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The Platoon School

A STUDY OF THE ADAPTATION OF THE ELEMENTARY SCHOOL ORGANIZATION TO THE CURRICULUM

By CHARLES L. SPAIN, Ph.D.
Deputy Superintendent of Schools, Detroit, Michigan.

THE AUTHOR undertakes to submit a new type of school organization, the platoon school, to this test: Does it square with the past? Does it serve the present? Does it hold abundant hope for the future?

The discussion is concerned with the genesis of the twentieth century curriculum and with an analysis of those social forces which have produced it. It is also concerned with the nature of the twentieth century school organization as it has evolved from the more simple forms which have preceded it. Finally, it is concerned with the twentieth century school building as the lineal descendant of the simple and primitive structures of an earlier day. In a word, it aims to discover how the platoon school squares with the past.

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A CRITIQUE OF METHODS OF ESTIMATING AND MEASURING THE TRANSFER OF TRAINING

ARTHUR I. GATES

Teachers College, Columbia University

In this paper will be reported the results of a study designed primarily to test several features of an experimental technique commonly designated as the "control group method" and to compare results obtained experimentally with results suggested (1) by pooled estimates of experts in education and psychology and (2) by an analysis utilizing the methods of multiple correlations based upon the initial performances only. These problems will be taken up in the order given.

Some Limitations of the Usual Control Group Technique

The control group technique, familiar to students of psychology, comprises the following main characteristics: (1) A series of initial tests both in the function (or functions) to be practiced specifically and in other functions to which the transfer of the effects of practice is to be ascertained; (2) a "control group" which receives no special training but is equivalent in ability on basis of the initial tests to the one (or more) practice or training groups who receive training in one (or more) functions, and (3) the repetition at the end of training of the same (or equivalent) tests given at the beginning. An effort was made to study some of the characteristics of this procedure.

The functions selected for training were two types of reading reactions; the subjects, three classes at each of the levels, Grades III, IV, V and VI, *i.e.*, 12 classes in all, in the Horace Mann School. The details concerning procedure, materials and results of educational import have been printed elsewhere;[1] only the facts necessary for the discussion of technique are given here.

[1] *Teachers College Record*, March, 1924.

Two types of training were adopted: (1) The Paragraph-question Method (later designated as the PQ method) which consisted in reading 10 minutes daily as rapidly as possible mimeographed passages for the purpose of answering questions placed below, calling for the main ideas. Each child had a booklet containing 85 pages of this prepared material. Results were scored; rate and comprehension computed; records made and displayed daily. (2) The Oral-recitation (OR) Method consisted of reading materials from selected books for three minutes followed by two minutes oral recitation; then three minutes reading and two minutes recitation, a total of 10 minutes daily the same as the PQ groups. Speed was emphasized, measured, recorded, and displayed; comprehension, in the form of outlining the story or ideas was emphasized but not objectively measured. Practice covered a period of a little more than one month although the total number of days' work put in by all members of each group, because of absences, was usually less than 20.

To measure the amount of transfer, the following tests were used:

1. Thorndike-McCall Scale for Ability to Understand Paragraphs.
2. Monroe's Standardized Silent Reading Test, Revised.
3. Courtis Silent Reading Test. Understanding of paragraphs.
4. Courtis Silent Reading Test. Rate. Score is number of words read per minute.
5. Word Perception Test, consisting of 24 blocks of words, of which the easiest and hardest follow:

Hat	Sat	Pot	Rat	Bat	Hat
Magnificent	Mountainous Distinction Magnifficant	Everlasting Magnificent Illustrious	Magnifersant Merchandise Measurement	Appointment Maggnifsunt Composition	

The task is to select and underline the word in the group which is the same as the word in the margin. This test was constructed to measure the speed and accuracy of the mechanical operations of word perception. Score is number of exercises done correctly.

6. Cancellation of Unlike Groups of Digits. This test consists of rows of pairs of numbers, mainly five digits each. The task is to cancel each number which is not identical with the number with which it was paired. Score is number of groups attempted minus three times the number of errors.

7. Picture-naming Test. A page containing clear outline drawings of 70 familiar objects, such as hat, watch, bite. The task is to write the names of the objects under the pictures as rapidly as possible. Score is number correct.

Tests 5, 6 and 7 form the basis of the analysis of the control group technique.

Improvement, both specific and transferred, was computed in terms of multiples of the standard deviations of the distributions of ability in the initial tests. That such SD gains afford the most adequate bases for comparison, one function with others, is the opinion of experts[1] in statistical methods.

The gains from specific practice, results for all four grades combined, were as follows: PQ reading, scored in terms of number of questions correctly answered 2.45 SD; PQ scored in terms of number

TABLE I.—SD GAINS FOR ALL GRADES COMBINED, TOGETHER WITH THE PE OF THE MEANS

		Average SD gains			Average SD gains minus control group gains		PQ gains surpass OR gains by
		Paragraph question	Oral recitation	Control	Paragraph question	Oral recitation	
Thorndike	Mean	0.72	0.55	0.27	0.45	0.28	0.17
McCall	PE	.035	.047	.030	.047	.054	.073
Monroe	Mean	0.76	0.56	0.31	0.45	0.25	0.20
Comprehension	PE	.054	.082	.072	.078	.109	.133
Monroe	Mean	0.68	0.53	0.45	0.15	0.08	0.07
Rate	PE	.061	.087	.081	.10	.12	.15
Courtis	Mean	0.62	0.62	0.29	0.33	0.33	.00
Comprehension	PE	.041	.080	.026	.05	.08	.10
Courtis	Mean	0.75	1.69	0.55	0.20	1.14	0.94
Rate	PE	.110	.240	.047	.13	.25	.24
Word	Mean	0.51	0.60	0.33	0.18	0.27	0.09
Perception	PE	.040	.029	.041	.056	.05	.07
Picture-naming	Mean	0.52	0.45	0.40	0.12	0.05	0.07
Writing	PE	.047	.061	.034	.059	.068	.09
Cancellation	Mean	0.33	0.35	0.30	0.03	0.05	0.02
	PE	.016	.017	.021	.027	.028	.039

[1] See manuals by Thorndike, Rugg, or Kelley.

of lines read 3.32 SD and the OR reading scored in terms of number of lines read 4.23 SD. With these specific gains, the transfer of improvement shown in Table I may be compared. In Table II, the net results of transfer, for the reading tests only, are arranged according to the different methods of scoring thus giving a better notion of the amounts.

TABLE II.—RESULTS ARRANGED TO YIELD THE FAIREST COMPARISON OF RELATIVE GAINS

Results of specific training shown at top of each column with transfer values below

PQ scored by number Q's correctly answered, average all grades = 2.45 SD	PQ scored number lines read, comprehension disregarded, all grades = 3.33 SD	OR, scored by number lines read, comprehension disregarded, grades IV, V, VI = 4.63
Thorndike-McCall, scored as above, gain = 0.45 SD or 18.4 per cent of specific improvement		Thorndike-McCall, scored by number Q's correct, results for same grades as above, gain = 0.34 or 7.30 per cent
Monroe Comprehension, scored as above, gain = 0.45 SD or 18.4 per cent		Monroe Comprehension, scored by number Q's correct, results for grade above, gain = 0.14 SD or 5.2 per cent
	Monroe Rate, scored as above, gain = 0.15 SD or 4.5 per cent	Monroe Rate, scored as above, same grades as above, gain = 0.00 SD or 0 per cent
Courtis Comprehension, scored as above, gain = 0.33 SD or 13.4 per cent		Courtis Comprehension, scored by number Q's correct, same grades as above, gain = 0.32 SD or 7 per cent
	Courtis Rate, scored as above, gain = 0.20 or 6.0 per cent	Courtis Rate, scored as above, same grades as above, gain = 1.03 SD or 22.2 per cent
Average gain, comprehension measures = 16.7 per cent	Average gain, rate tests = 5.25 per cent	Gain, rate tests, Courtis only = 22 per cent Average gain, comprehension tests = 5.2 per cent

With regard to the quantitative aspects of transfer the main facts are: (1) The amounts of transfer are small; (2) they vary greatly depending on the similarity of materials and the methods of scoring; and (3) they differ according to the type of reading reacting trained. Reading is by no means a unitary function, an ability to be learned in general. Reading is reacting and the number of types which are, or may be, acquired is great. To develop one form of reading is not to increase others equally; in the main each must be specifically developed.

In this article we are mainly interested in the validity of the control group technique. The three tests, *word-perception, picture-name writing* and *digit cancellation* tests were introduced to provide a check on certain features of the method.

The *word-perception* test was designed to measure, in as pure form as possible, sheer speed and accuracy of the perception or recognition of word forms. Both the PQ and the OR forms of training result in an increase in this ability over and above that due to ordinary school training (control group); the OR more than the PQ—0.27 SD and 0.18 SD respectively. Our interpretation of these facts is that reading in which rate is emphasized and improved results in a sharpening of the skill with which words are mechanically perceived. The oral-recitation method apparently gave more emphasis to, and probably but not certainly resulted in, greater improvement in speed—a result suggested by the measures of transfer in the word-perception test.

The cancellation-of-unlike-digits test involves neither the perception nor the writing of words. It was selected as a means of measuring more or less well the general technique of taking tests, which conceivably might be improved by the PQ and the OR groups. Just what devices constitute this technique we do not know and can merely surmise—possibly such things as getting a quicker start, placing material in a better position, losing no time in curious surveys of the whole test, increasing control of attention or of excitement, and the like. Whatever they may be, these items are acquired in about equal but slight amounts by both practice groups. Part of the specific and transferred improvement, then, is not reading as such but improved technique in taking pencil-and-paper tests.

The picture-naming test was introduced to measure the improvement in ability to write a word or two as a response to a stimulus, under test conditions. The stimuli were purposely made easy and familiar—they were clear cut drawings of familiar objects—in order

to measure the writing responses, rather than the activities of perception emphasized in the preceding test.

Table I shows that the paragraph-question groups, which answered the questions by writing a word or two or by underlining a word, excelled the control group by 0.12 SD, whereas the oral-recitation groups, which did no writing, gained in this ability somewhat less; the gain being 0.05 SD greater than that of the control group. In the case of the PQ group, at least, part of the specific improvement, and part of the transfer to other tests, may be not reading at all but improvement in writing words in response to stimuli under test conditions.

The gains for the OR groups were the same in the cancellation and Picture-name Writing tests; both are due, presumably, to general technique in taking tests. For the PQ the gain in the Picture-name Writing test is greater than in the cancellation test—0.12 SD and 0.03 respectively. The former test gives play not only to writing under test conditions, but also to the other features of technique which produce the smaller gain. The difference[1] (0.09 SD) apparently measures roughly the influence of increased skill in writing word responses during tests. Since the OR group had no such practice, it reveals no gain in this test beyond that due to general technique.

The transfer of abilities that are intrinsically reading abilities is, then, somewhat less than indicated by the figures in Table II. To ascertain more closely the transfer of abilities intrinsic to reading, we may take the data of Table I and treat them as follows: From the specific gain in PQ training, subtract 0.12 SD, the approximate amount due to acquisition of general efficiency in taking tests and in writing word responses under test conditions;[2] from the specific gains in OR subtract 0.05 SD, the amount due to general test-technique training; from the transfer reading tests taken by the PQ groups subtract 0.12 SD if answers were made in writing and 0.03 SD, the transfer of general technique if there were no written responses; from the transfer reading tests for the OR group subtract 0.05, the amount of transfer due to factors not intrinsically reading ability. The resulting values are given in Table III.

The corrected estimates are slightly smaller than those based upon the gross scores. They, or rather the considerations which lead to

[1] The PE of this difference is less than 0.06.

[2] Perhaps the amount subtracted should be larger, since "technique" and "ability to write word responses" will not themselves transfer completely to other tests, but we cannot, from our data, tell what the specific gains in these respects were.

TABLE III.—TRANSFER AFTER ALLOWANCES HAVE BEEN MADE FOR IMPROVEMENT IN FACTORS NOT INTRINSICALLY READING ABILITIES

Specific gain, PQ groups, all grades, score, number correct = 2.33 SD	Specific gain, PQ groups, all grades, score, number lines read = 3.21 SD	Specific gain, OR groups, score, lines read, Grades IV, V, VI = 4.58 SD
Transfer to Thorndike-McCall = 0.33 SD or 14 per cent		Transfer to Thorndike-McCall = 0.29 SD or 6.3 per cent
Transfer to Monroe Comprehension = 0.33 SD or 14 per cent		Transfer to Monroe Comprehension = 0.09 SD or 2 per cent
Transfer to Courtis Comprehension = 0.21 SD SD or 9 per cent		Transfer to Courtis Comprehension = 0.27 SD or 6 per cent
	Transfer to Courtis Rate = 0.17 SD or 5.3 per cent	Transfer to Courtis Rate = 0.98 SD or 21.2 per cent

them, are of value mainly in disclosing the extreme complexity of the problems of appraising the transfer of training.

The customary control group technique, it is now apparent, is not wholly adequate for the measurement and analysis of the transfer of improvement. Failure to control the transfer of improvement in mere technique in taking tests which has been quite universal in investigations of the past, has given a fictitious appearance of transfer in general ability to add, do geometry, grammar, etc., where it did not exist or where it existed in smaller quantities, *since it is probable that improvement in ability to take tests generally results in making the total transfer larger than that due to gain in addition, geometry, etc., per se.*

It is suggested, therefore, that in future work the investigator scrutinize his tests with care, considering them not merely as measures of ability to read, add or what not, but as a measure of various abilities, to perceive words or digits, to adjust to a certain kind of task-under-time-pressure, to control attention, to write words or figures in such and such a way, and so forth. Where the interest is in measuring reading or some other abilities specifically, control for all of the other factors must be provided and these extrinsic abilities allowed for.

For this purpose, one method has been suggested above, but another and probably better method may be used. According to the present custom, the control group takes the initial and final transfer tests but

does nothing—at least nothing experimentally controlled—during the interval in which the "practice" group receives its special training. If the control group were given practice simultaneously in exercises similar in mechanical form and equally interesting but as different as possible in content, it would yield a measure not perfect but better than none, both of the specific gain in the "extrinsic" abilities and of the transfer of these abilities to the final transfer tests. For example, if the practice group were trained in reading paragraphs, jotting down the answers to questions, the control group might be trained in searching through "paragraphs" of groups of digits, writing down the number of those containing both 2 and 3, 1 and 6, and 2 and 8. They would probably do better on the final tests, given to the reading group, than a control group which had no practice in tests during the period, and this gain would be extrinsic to rate and comprehension of reading words.

May the Amount of Transfer of Improvement from One Function to Others Be Foretold?

To ascertain the degrees of transfer from each to every other type of reading, of which there are so many—not to mention other subjects—and for pupils at different stages of advancement, will entail a tremendous amount of experimentation, well worth the time and expense, however. Meanwhile, are there devices more expeditious which will produce results useful if not perfect? There are at least two conceivable short-cuts which may now be tried out since we have at hand the results obtained by direct experimentation. First, there are, possibly, experts in psychology who would be able, after careful scrutiny of the several functions, to predict the relative, if not the absolute, degrees of transfer with an accuracy sufficiently great to merit utilization until the results of more scientific inquiries are available.

Five psychologists consented to estimate the degrees of transfer to the several tests here used, and a few other functions from the two forms of training. The descriptions of the tests and forms of training given these judges were brief and the estimates were therefore made in general terms. The functions, included in the list in addition to those studied in the experiment were, briefly:

6. Proof-reading—to detect errors in spelling only.
7. Reading to evaluate the literary merits of short essays.
8. Reading history lessons for purpose of remembering important facts for recitation the following day.

9. Reading fiction, results measured by rate, assuming that accuracy and fullness of understanding as well as enjoyment are rendered constant.

The estimates in terms of the percentages of specific SD gains which would transfer to each test are given in Table IV. They are, on the whole, much larger than those experimentally obtained. If the

TABLE IV.—ESTIMATES BY JUDGES OF THE PERCENTAGE OF SPECIFIC GAIN WHICH WILL TRANSFER TO THE FUNCTION INDICATED

Judge	Thorndike-McCall	Monroe Comprehension	Courtis Comprehension	Courtis Rate	Perception of Words	Proof-reading	Judge literary merits	Read history	Read fiction
Trained in paragraph-questions									
A	70	60	60	80	10	10	0	60	70
B	20	18	18	3	1	0	4	6	1
C	90	20	90	40	−5	−5	0	5	5
D	75	40	70	70	10	5	0	10	0
E	70	60	50	40	5	0	15	50	20
Mean	65.0	39.6	57.6	46.6	4.2	2	3.8	26.2	19.2
Rank	1	4	2	3	5				
Trained in Oral-recitation									
A	60	50	50	80	15	5	10	70	40
B	12	12	12	10	1	0	3	8	1
C	60	20	60	86	0	0	0	5	5
D	25	40	70	70	0	0	0	50	0
E	30	25	20	30	5	0	5	25	20
Mean	37.4	29.4	42.4	55.0	4.2	1.0	3.6	31.6	13.2
Rank	3	4	2	1	5				

figures are considered relatively, by comparing magnitudes of estimated and obtained results as ranks, the agreement between the two is close. Between the several judges agreement is also close. Since the judges estimate relative transfer very well in those cases which we are able to check, we may assume that the ranking of the other functions—numbered 6, 7, 8 and 9—are probably correct. Either form of training above described, then, will probably improve rate of reading history lessons for the purpose of remembering the facts by an appreciable amount, rate of reading fiction somewhat less and ability to judge the literary merits of essays, or read proof by amounts scarcely perceptible.

The predictions of competent judges, then, are suggestive substitutes for experimentation under certain conditions when sane objective guidance is provided. Experts in psychology are able to judge relative degrees of transfer to different described functions fairly well but are unable to appraise accurately, the absolute magnitudes at least not without samplings of results very closely related.

Predictions of Transfer Based on an Analysis of Inter-correlations of Initial Tests

A second possibility of predicting the amounts of transfer lies in the analysis of the correlations of the tests with the function specifically trained and with others. This type of work is eminently worth doing since it should assist in an understanding of the significance of correlations, especially multiple and partial correlations. These techniques as frequently employed are essentially substitutes for experimental analyses. By means of multiple correlations, for example, teams of tests are suggested, each with a given weight which theoretically should give a higher correlation with a specified criterion than a single test or any other combination of tests. It is rare that the accuracy of these predictions, based on statistical analyses, is verified by actual experiment with the team. Again, causal or common elements isolated by partial correlation are alleged to have a certain potency or influence which is rarely further tested.

Thomson,[1] to give an outstanding example, has shown certain pitfalls in arguments concerning the causes of correlations and concerning the nature of abilities, based on analyses of correlations among them. He has shown that not only a single type but numerous types of affinities and antagonisms may be found as the source of an obtained coefficient. Correlations do not always indicate common elements similarly determined; hence interpretation is usually hazardous. It appears, then, that where experimental results as in the present study have been obtained it is highly desirable to analyze the data statistically and compare results. In this way some of the legitimate uses and limitations of the method of correlation may be ascertained.

Accordingly, for the PQ group the most reliable measures of ability in the trained function—the sum of the scores for all of the practice periods—were obtained for the pupils of Grades IV and V which were combined. These scores for PQ were then correlated with the scores in the initial transfer tests which in turn were correlated with each

[1] In "On Hierarchical Order among Correlation Coefficients." *Biometrika*, Aug., 1923, and in earlier papers.

other. The coefficients are given in Table V. Study of this table will reveal a rough approximation between the size of the correlations of the tests with achievement in PQ and the magnitude of transfer. The correspondence is by no means perfect as might have been predicted from such information as we have concerning the nature of the determinants of correlations.

TABLE V.—THE OBTAINED CORRELATIONS, ZERO ORDER, AMONG THE TESTS

	Paragraph Questions	Thorndike-McCall	Courtis Rate	Courtis Questions	Monroe Comprehension	Picture-name	Cancellation Digits	Word Perception
Paragraph Questions	...	.62	.62	.73	.68	.29	.28	.57
Thorndike-McCall	.62	...	.49	.39	.61	.07	.27	.51
Courtis Rate	.62	.49	...	.50	.56	.25	.30	.51
Courtis Questions	.73	.39	.50	...	.53	.55	.29	.52
Monroe Comprehension	.68	.61	.56	.53	...	.31	.16	.61
Picture-name	.29	.07	.25	.55	.31	...	−.03	.29
Cancellation Digits	.28	.27	.30	.29	.16	−.03	...	.26
Word Perception	.57	.51	.51	.52	.61	.29	.26	

Each correlation is the outcome of many interlacing factors. Some of the likely factors are known. The degree of reliability of a test is one; other things equal, the correlations will be higher the greater the reliability of the tests. Age is another; other things equal, the closer any two tests are related to age the more highly they will be correlated with each other. General intelligence is a third; the closer two tests are associated with intelligence, the higher they will be correlated with each other. Theoretically, it would seem that eliminating by statistical devices the differences in reliability of the measures, the influences of age and intelligence, and necessarily other extrinsic influences if such there are, the residual correlations might bare the common factors specific to reading as such, the "specific" abilities shared by two reading reactions. At least, this is one possibility. To the degree that these common abilities are extensive the residual correlations will be large and transfer should be correspondently great.

To eliminate the influence of the unreliability of the measures it is necessary to secure a self-correlation or "reliability coefficient." The reliability coefficients for the PQ results were based upon correlations of two halves of the scores; the others were based on correlations between tests before and after training. The latter coefficients are

not perfect since the training influences the correlations somewhat. The closest approximations to the reliability coefficients that we can make are as given in Table VI.

TABLE VI.—APPROXIMATE RELIABILITY COEFFICIENTS

Paragraph Questions	= 0.98	Thorndike-McCall	= 0.89
Courtis Rate	= 0.88	Courtis Questions	= 0.86
Monroe Comprehension	= 0.78	Picture-name Writing	= 0.80
Cancellation of Digits	= 0.80	Word Perception	= 0.85
Chronological Age	= 1.00	Mental Age	= 0.90

Using the above reliability coefficients as a basis, the several correlations were corrected for attenuation due to unreliability of the measures. The corrected coefficients are presented in Table VII.

TABLE VII.—CORRELATIONS CORRECTED FOR UNRELIABILITY OF MEASURES

	Paragraph Questions	Thorndike-McCall	Courtis Rate	Courtis Questions	Monroe Comprehension	Picture-name	Cancellation Digits	Word Perception	MA
Paragraph Questions and	....	0.67	0.66	0.79	0.77	0.33	0.30	0.62	0.61
Age and	0.26	0.27	0.27	0.27	0.26	0.33	0.34	0.30	0.34
MA and	0.61	0.68	0.62	0.61	0.69	0.10	0.17	0.56	

By the technique of partial correlations, the influence of age and mental age singly has been eliminated as shown in the first three lines of Table VIII and in the last line are given the partial correlations after both age and intelligence have been eliminated.

TABLE VIII.—PARTIAL CORRELATIONS OF THE FIRST ORDER

	Paragraph Questions	Thorndike-McCall	Courtis Rate	Courtis Questions	Monroe Comprehension	Picture-name	Cancellation Digits	Word Perception
Paragraph Questions (age eliminated)	....	0.66	0.65	0.78	0.76	0.27	0.24	0.61
MA (age eliminated)	0.60	0.67	0.60	0.59	0.68	−0.01	0.06	0.50
PQ (MA eliminated)	...0	0.44	0.43	0.66	.61	0.33	0.26	0.43
Partial Correlations of the Second Order								
Paragraph questions (age and MA eliminated)	....	0.42	0.43	0.65	0.60	0.32	0.26	0.42

The partial correlations of PQ with the other tests with both age and intelligence eliminated are the ones sought for the purpose of disclosing most accurately the degree of common bonds between the tests by means of which transfer may theoretically occur. Roughly, they agree with the experimental findings.

The results of the three methods of study may be compared on the basis of the data in Table IX. In this table the transfers experimentally determined and estimated by judges are given in percentages of the specific gain, a manipulation that cannot be accomplished with the data resulting from the statistical analysis of initial scores which are given in form of correlations. The agreement among the three methods is disclosed roughly by the comparison of the rankings of figures which indicate the relative amount of transfer. The correlation based on rank differences (ρ) between the experimental results or judges' estimates is 0.58; between experimental results and analysis by correlations, 0.71; between judges' estimates and correlations, 0.38.

TABLE IX.—THE TRANSFER FROM PQ TRAINING TO OTHER FUNCTIONS INDICATED BY THREE DIFFERENT METHODS OF ANALYSIS

Transfer to	(1) Transfer shown by experiment		(2) Transfer estimated by judges		(3) Transfer suggested by correlations	
	Per cent	Rank	Per cent	Rank	r	Rank
Thorndike-McCall.....	18.4	1.5	65.0	1	0.42	4.5
Monroe Comprehension...	18.4	1.5	39.6	4	0.60	2
Courtis Comprehension ...	13.4	3	57.6	2	0.65	1
Courtis Rate.....	8.2	4	46.6	3	0.43	3
Perceptive words.....	7.3	5	4.2	5	0.42	4.5
Picture-name.....	4.9	6	....	..	0.32	6
Cancellation Digits	1.2	7	....	..	0.26	7

If only the first five functions, which are common to all three methods, are utilized the ρ's are 0.58, 0.28 and 0.38, respectively.

The disagreements occur in connection with the three tests, Thorndike-McCall, Monroe Comprehension, and Courtis Comprehension. Judges and correlations, for example, place Courtis higher than the experimental results. On inspection, reading in the Courtis test seems

to have a great deal in common with the function trained. What then is the probable cause of this disagreement?

A possible reason for the low amount of transfer in the experiment may have been due to a lapse in interest and application during the final test with this instrument. A second reading of this rather trivial material induced more indifference, perhaps, than diligence. The correlations, it should be noted, were based on the results of the first test, and were therefore not subject to the same source of error. It is not impossible, therefore, that transferred ability for this test had been developed and was available but not fully utilized.

A contrary explanation, difficult to evaluate, might be based on the unreliability of the resulting partial correlations. Originally a rough measure, and repeatedly corrected, each correction adding to the probable error in certain respects, the correlations are but coarse approximations. It is unlikely, furthermore, that all of the factors, not intrinsically reading abilities, have been completely eliminated. Our measures of intelligence are but approximate, and other influences —educational and temperamental—have not been eliminated at all. The discrepancy then may be exaggerated by too much statistical manipulation. However, if all of these factors with which the residuals are alloyed are nearly equally distributed among the several tests, the results would have a distinct suggestive value. It is as such that they should be taken. Neither the experimental nor the statistical analysis is without errors and inadequacies. Each serves to check the other. When discrepancies between results appear, we must instigate closer scrutiny and further experimentation.

To summarize: Psychologists judge the relative degrees of transfer fairly well. They can answer quite accurately the question: Will transfer from A to B be greater than that from A to C or A to D? But their judgments of the absolute amount of transfer vary considerably. It is also possible, by means of statistical analysis of measured abilities in several functions to estimate roughly the relative amounts of transfer, at least under certain conditions. Neither of these shorter methods is a satisfactory substitute for experimental analysis, but the technique of multiple correlations provides a supplement and check that, in many experiments as in the present one, may be profitably used. There is a need for further studies in which results experimentally obtained are predicted by statistical analyses of initial tests both for the purpose of ascertaining the legitimate uses and limitations of correlation methods and of finding, possibly, short methods of securing approximate results quickly and economically.

MENTAL CAPACITY OF CHILDREN AND PATERNAL OCCUPATION

M. E. HAGGERTY AND HARRY B. NASH

University of Minnesota

The relationship of paternal occupation to the opportunities afforded offspring is a matter of deep social significance. The present paper bears upon this general question to the degree that the capacity of children to profit by elementary and secondary school instruction is conditioned by the occupational status of their parents. The data are derived from the results of tests given to pupils in connection with the survey of the New York rural schools.[1] Only the results from the Haggerty Intelligence Examinations Delta 2 will be considered here although data are available from the Haggerty Intelligence Examination Delta 1 and the Miller Mental Ability Test.[2]

That the "capacity of children to profit by school instruction" is measured by the so-called intelligence examinations may be assumed since the literature abundantly supports this view.[3] The representative character of the examination here used has been adequately demonstrated.[4] The evidence clearly shows that high standing in this examination is a clear indication of ability to achieve success in existent elementary and high school curricula.

The ground may be immediately cleared of the much mooted but unsolved question as to whether this "capacity" is wholly inherited or is partly achieved in the course of an individual life. Either party to this time-honored dispute may have such consolation as he can derive from the facts to be here presented. Their bearing upon practical social and educational matters is important whatever may be their relevancy to more theoretical concerns and this practical function justifies their being recorded without theoretical interpretation. The material is sufficient in scope and amount to be regarded as representative of widespread American conditions.

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[1] Haggerty, M. E.: Educational Achievements. *Rural School Survey of New York State*, Vol. VI.

[2] *Ibid.*

[3] *Ibid.*

[4] Haggerty, M. E.: Intelligence Examination, Delta 2. *Journal Educational Psychology*, Vol. IV, p. 257ff.

In the collection of test results careful consideration was given to securing a satisfactory sampling of the rural[1] population of the State. That this sampling was representative of the country at large is attested by the comparison in Table I which shows the percentage for several large occupational groups in the New York data and the 1920 census figures for the entire country. The close approximation of the proportions in the two groups gives the findings of our study a representative character reaching much beyond the bounds of a single State.

TABLE I.—SHOWING THE PERCENTAGE OF FIVE OCCUPATIONAL GROUPS IN THE POPULATION OF THE UNITED STATES (CENSUS 1920) AND THE PERCENTAGE OF EACH OCCUPATION IN THE NEW YORK DATA

	Occupational groups				
	Professional	Business and clerical	Skilled and semi-skilled	Agricultural	Unskilled
Per cent in U. S.....	4.5	13.0	27.0	44.0	12.0
Per cent in New York data.....	5.2	14.0	23.3	46.0	11.0

TREATMENT OF RESULTS

Eight thousand one hundred and twenty-one school children are included in this study. Grades III to VIII provide 6688 of these and the high schools furnish 1433. The raw intelligence examination score of each child was converted into an intelligence quotient.[2] Tables II and III show the distribution of these quotients, for the grade and high school groups respectively. The grade group shows a median IQ of 95.8. The distribution of the grade group is approximately normal, although skewed slightly to the left owing to the fact that 46 per cent of the cases are drawn from the farmer class which has a median IQ of 91.

[1] In New York State a rural school is one in a community not exceeding 4500 in population.

[2] For method see *Journal Educational Psychology*, Vol. XIV, p. 257ff.

TABLE II.—DISTRIBUTION OF INTELLIGENCE QUOTIENTS FOR 6688 PUPILS IN GRADES 3 TO 8

IQ	CASES
50– 54	18
55– 59	59
60– 64	120
65– 69	221
70– 74	344
75– 79	452
80– 84	632
85– 89	638
90– 94	755
95– 99	686
100–104	599
105–109	552
110–114	437
115–119	354
120–124	245
125–129	199
130–134	129
135–139	94
140–144	55
145–149	48
150–154	29
155–159	13
160–164	2
165–169	3
170–174	3
175–179	1
Total	6688
Median	95.8

The apparent bimodality of the high school group (see number of cases at 125–129 interval) is probably fictitious since 18 years was considered the maximum mental age when the quotients were calculated. Later correction of the table of norms up to 20 years[1] would probably obviate this concentration of cases at one point and show an approximate normal distribution as in the case of the grade group.

[1] *Ibid.*

TABLE III.—DISTRIBUTION OF INTELLIGENCE QUOTIENTS FOR 1433 HIGH SCHOOL PUPILS

IQ	CASES
60– 64	1
65– 69	1
70– 74	2
75– 79	13
80– 84	45
85– 89	64
90– 94	95
95– 99	153
100–104	151
105–109	176
110–114	156
115–119	111
120–124	92
125–129	231
130–134	51
135–139	48
140–144	18
145–149	12
150–154	6
155–159	3
160–164	2
165–169	2
Total	1433
Median	110.5

OCCUPATIONAL GROUPS

The grouping of cases is on the basis of the father's occupation as stated by the teacher of the pupils when the tests were given.[1] Fifty-five occupations are listed with from 9 to 3098 cases each. Most of the designations will carry their own meaning but a word of explanation may be needed to clarify others. "Official" includes men holding responsible positions in large business concerns. "Merchant" includes importers, exporters, and all those doing mercantile business on a large scale. "Foremen" includes superintendents in factories, and managers of small business concerns. "Newspaper business" includes editors, authors, and publishers. "Manufacturers" include men manufacturing on a small scale. "Inspector" is a heterogeneous group including men described as gas inspectors, meat inspectors, custom inspectors, and the like. "Metal worker" includes foundry workers, steel workers, and allied trades. "Unclassified profes-

[1] A special method designed to secure uniform methods in listing occupations was used.

sional" and "Unclassified skilled workers" are made up of occupations falling into professional and skilled-worker groups according to Taussig's classification referred to later in this article. There were too few representatives in these cases to be classified separately.

Intelligence and Occupation

If we may be allowed to use the word "intelligence" as designating the differential capacities of pupils of the same chronological age to make scores in the Haggerty Intelligence Examination Delta 2, it is obvious that there are clear-cut intelligence levels in the occupational groups listed in Table IV. Not only do the medians of the first 12 groups exceed the medians of the last seven, but almost 75 per cent of the first 12 groups which include nearly 400 children exceed all but the best 25 per cent of the last seven groups including nearly four thousand cases. In other words, but little more than one-fourth of the children of miners, masons, stoneworkers, laborers, farmers, bakers, and blacksmiths appear to be as able to profit by the work of the elementary school as that school is now organized as are three-fourths of the children of druggists, brokers, officials, insurance men, lawyers, teachers, office workers, doctors, dentists, accountants, bankers and merchants.[1] Such differences as these have great significance for education if they should be substantiated by extensive investigation. They go beyond the results of the Army examinations which showed that the men actually pursuing an occupation were characterized by a definite intelligence status. The present data show that this intelligence level also characterizes the children of such parents. The father's occupation appears to afford a rough index of the child's intelligence of its capacity to profit by schooling, and possibly of the type of school most serviceable to its needs.

No one expects to find occupational groups completely discrete in any important human trait. Distributions of large numbers of any such group will show overlappings at the extremes, at least, over other groups. How little of such overlapping may occur is shown in Fig. 1, giving the percentile curves for the lawyer and the miner groups each of 53 cases. Only about 5 per cent of the miners' children are as

[1] The authors have no desire to generalize facts beyond their implicit meaning. It is conceivable that change in home environment or changed school conditions during early years might alter somewhat the relative position of the several groups. The present data neither support nor negate such a possibility.

TABLE IV.—SHOWING OCCUPATIONAL GROUPS OF GRADES III TO VIII AND OF HIGH SCHOOL CHILDREN. OCCUPATIONS ARRANGED IN ORDER OF MEDIAN INTELLIGENCE QUOTIENTS FOR GRADE GROUPS

Occupation	Grade			High school		
	Number of cases	Median	Middle 50 per cent	Number of cases	Median	Middle 50 per cent
Druggist	12	124	108–131	11	125	120–127
Broker	24	123	99–138	13	122	113–127
Official	33	120	101–129	22	109	91–125
Insurance	36	119	106–131	6	99	92–114
Lawyer	53	119	107–132	17	121	117–125
Teacher	47	118	102–128	16	121	108–134
Office worker	85	114	95–127	13	121	113–133
Doctor	26	114	102–128	21	118	107–125
Dentist	11	114	109–122	7	111	111–122
Accountant	28	113	106–125	4	126	125–126
Banker	22	112	107–127	10	117	111–125
Merchant	12	111	107–120	12	117	111–125
Station agent	22	110	99–118	17	108	97–122
Printer	24	110	95–126	9	125	121–125
Real estate	23	109	92–121	12	105	89–117
Foreman	153	109	96–122	69	111	104–124
Minister	27	109	95–122	26	112	99–125
Newspaper business	22	109	100–134	14	125	105–135
Civil engineer	11	108	94–119			
Architect	13	107	98–120			
Electrician	34	107	95–120	13	106	95–122
Manufacturer	64	107	94–122	14	110	105–125
Unclassified professional	28	107	94–112			
Salesman	126	106	95–124	49	125	110–125
Barber	34	104	88–114	2	105	Cases too few to record
Clerk	45	103	91–116	15	101	92–110
Retail merchant	329	103	93–118	147	109	100–125
Unclassified skilled	61	102	88–112	81	108	97–119
Plumber	28	101	94–108	3	112	Cases too few to record
Mechanic	103	101	90–115	19	104	94–118
Machinist	89	99	90–107	19	105	100–125
Inspector	17	98	85–116			
Painter	86	98	86–107	23	105	95–125
Tailor	30	98	83–110	9	106	92–118
Engineer	76	98	87–111	11	106	97–117
Motorman	9	97	76–107	4	106	92–117
Brakeman	14	97	73–105			
Cheesemaker	13	97	88–116			
Mail-carrier	39	97	87–109	8	105	102–120
Metal-worker	58	96	87–111			
Contractor	61	96	82–115	27	105	96–118
Truck-driver	77	96	80–107	12	108	100–117
Chauffeur	43	96	86–107	5	112	99–123
Carpenter	237	96	86–107	57	104	93–119
Policeman	11	95	82–110	4	105	94–107
Janitor	28	95	83–107	6	103	92–107
Factory-hand	269	93	81–103	7	99	97–117
Shoemaker	20	92	76–108	4	113	107–116
Blacksmith	43	92	82–103	13	107	97–122
Baker	14	92	81–102			
Farmer	3098	91	82–103	489	106	97–119
Laborer	691	89	76–102	57	112	99–120
Stone-worker	41	88	76– 98			
Mason	53	87	79–105	6	91	98–115
Miner	54	80	72– 87	4	105	95–110

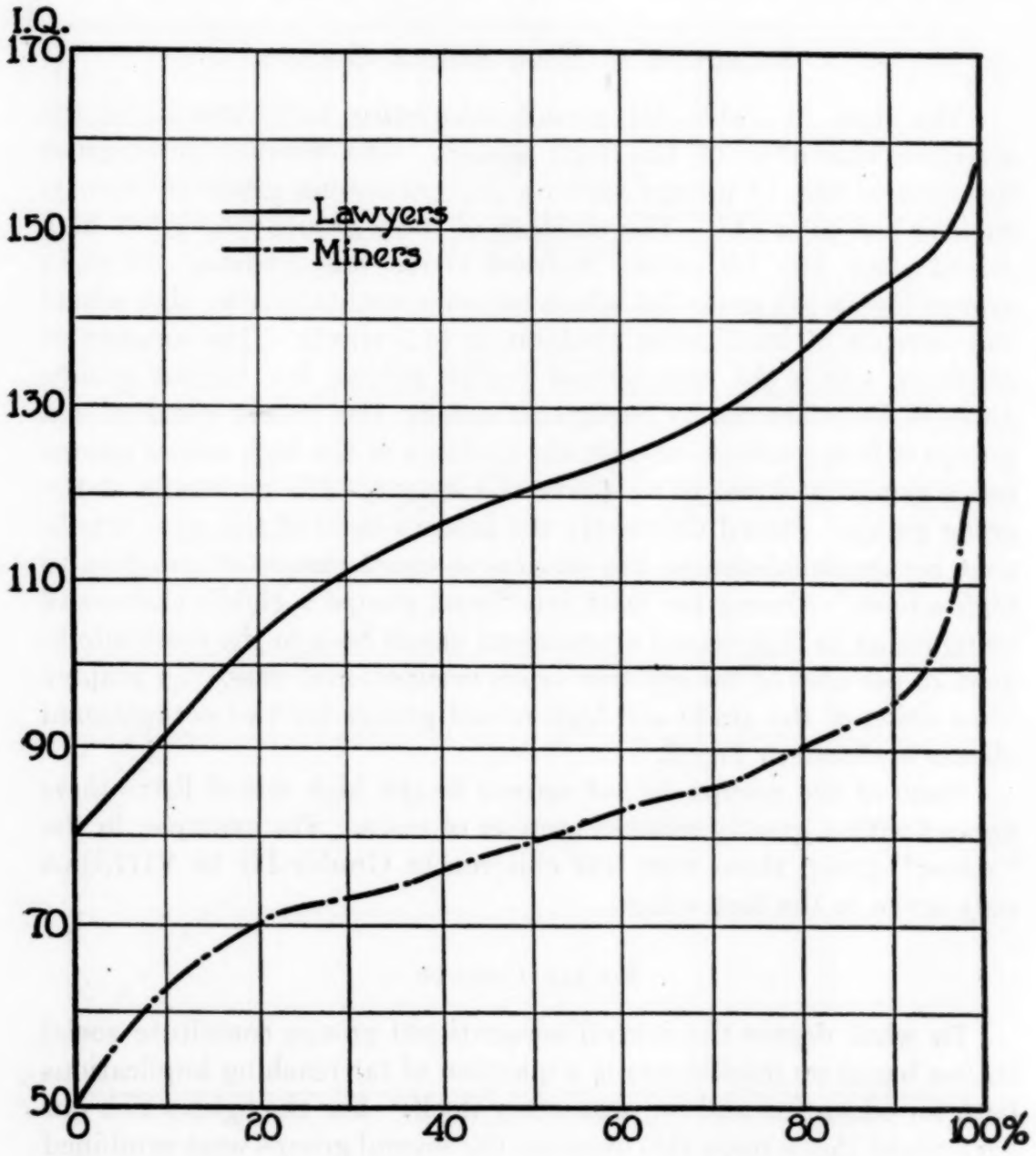

FIG. 1.—Percentile curves for two occupational groups found in Grades III–VIII.

intelligent as 80 per cent of the lawyers' children and no miner's child is as intelligent as the median child of the lawyer group.

Selection in High School Groups

The data in Table III permit interesting inferences as to the selective character of the high school. The average intelligence quotient of the 12 groups ranking highest among grade children is slightly less than 117. The children of these groups who go to high school show but 1.3 points increase above this median. Of eight groups low in the grade list which have representatives in high school the increase of intelligence quotient is 14.5 points. The amount of selection which the high school makes among the highest groups appears therefore to be negligible; among the lowest occupational groups it is exceedingly severe, the medians of the high school groups being generally equal to or above the seventy-fifth percentile of the grade group. Stated differently the median child of the most intelligent occupational classes has an almost equal chance of going on to high school. Among the least intelligent groups a child's chances of being found in high school are unequal unless he is in the most intelligent 75 per cent of the children of his occupational class.[1] A graphic illustration of the grade and high school groups for two occupational classes is shown in Fig. 2.

Some of the groups do not appear in the high school list; others appear with a greatly reduced number of cases. For example, in the "miner" group there were 269 children in Grades III to VIII, but only seven in the high school.

Social Groups

To what degree the several occupational groups constitute social classes based on intelligence is a question of far reaching implications both for education and for democracy itself. For the light which our data might throw upon this question the several groups were combined according to a modified form of Taussig's classifications.[2] The modification consisted in the segregation of the farmer group which had the largest number of cases and which did not lend itself easily to inclusion

[1] The inferences apply only to New York conditions at the time the tests were made. Whether other types of high school would afford larger opportunity for the less intelligent children is of course an open question.

[2] Taussig: "Principles of Economics," Vol. XII, pp. 134–148.

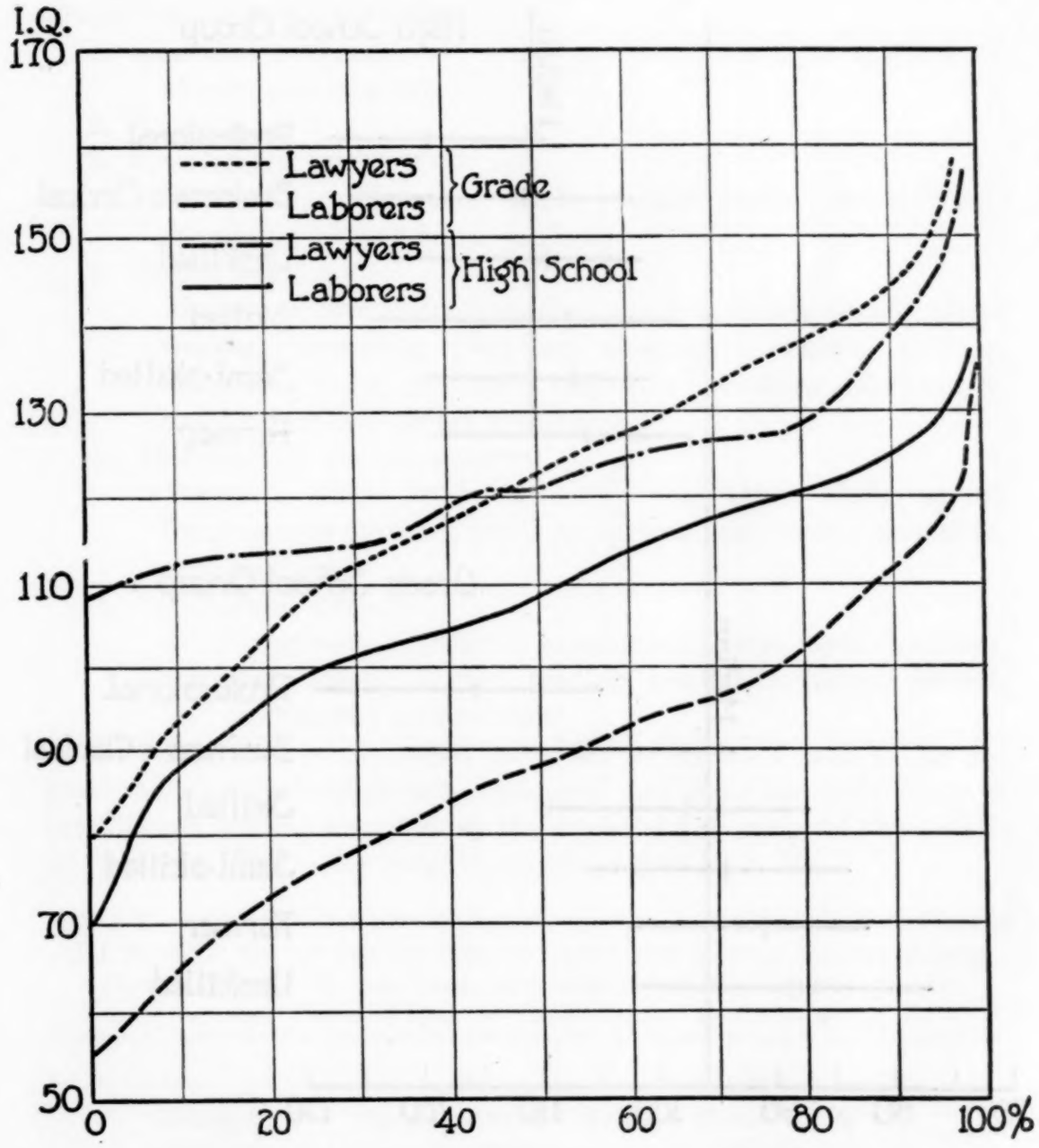

Fig. 2.—Percentile curves for the laborer and lawyer groups found in grades and in high school.

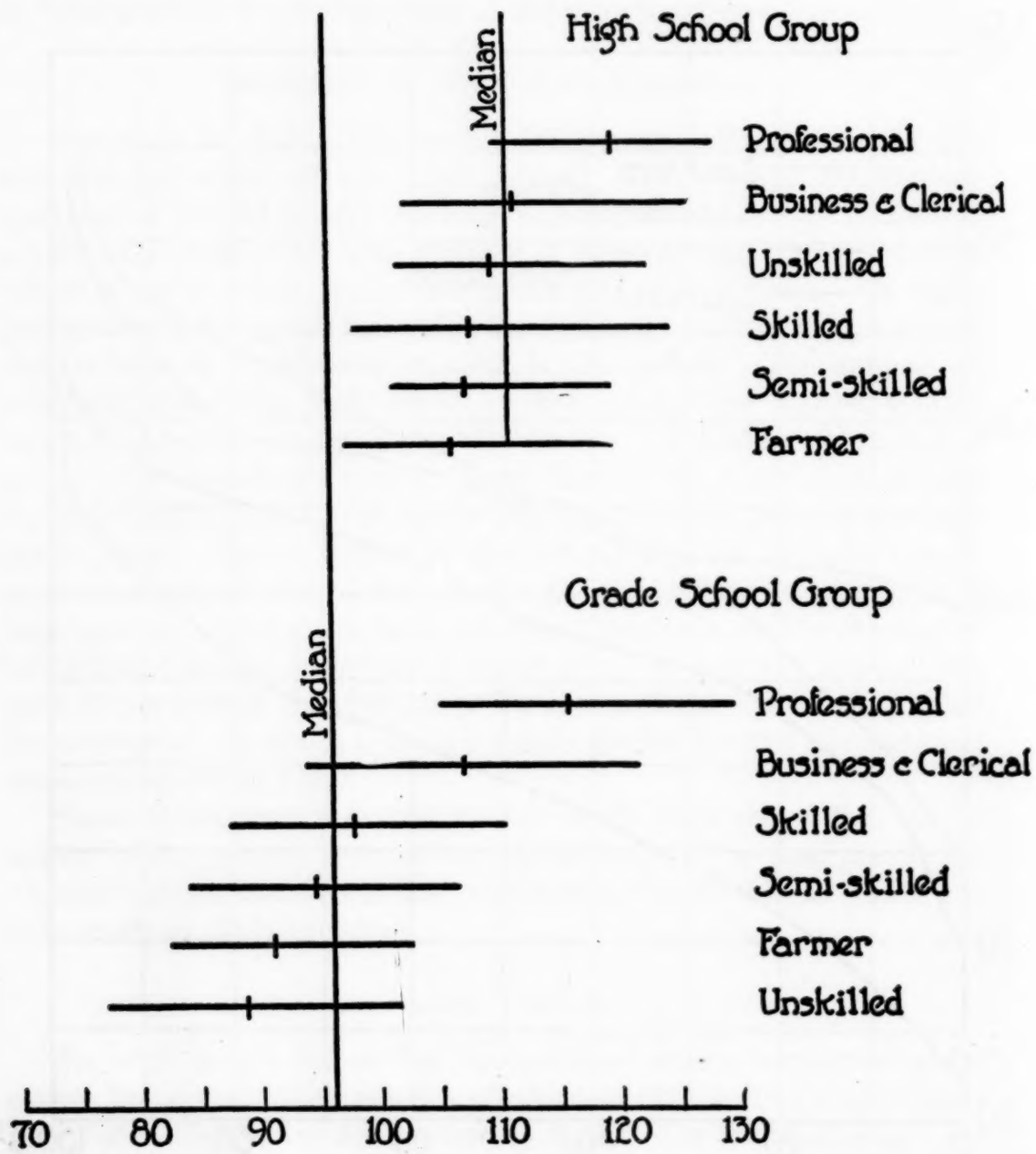

FIG. 3.—Showing spread the middle per cent in grade and high school groups based on Taussig's classification.

in any of his five groups. The resulting six classes with the groups composing them are as follows:

1. Unskilled workers:
   Miners and laborers.
2. Farmers.
3. Semi-skilled workers:
   Brakeman, policeman, barber, mail-carrier, truck-driver, chauffeur, factory-hand, janitor.
4. Skilled workers:
   Mason, printer, carpenter, cheesemaker, metal worker, stone worker, inspector, plumber, shoemaker, baker, painter, machinist, tailor, mechanic, engineer, electrician, blacksmith, and unclassified skilled workers.
5. Business and clerical workers:
   Foreman, office work, salesman, contractor, clerk, agents (express and station), retail merchant, real estate, insurance, manufacturer.
6. Professional workers:
   Civil engineer, architect, accountant, newspaper business, druggist, broker, lawyer, teacher, banker, minister, dentist, and unclassified professional.

The data thus re-combined are given in Tables V and VI for the grade and high school groups separately and show the total range of intelligence quotients as well as the medians and range of the middle 50 per cent. The latter range is shown graphically in Fig. 3.

TABLE V.—SHOWING COMBINED OCCUPATIONAL GROUPS REPRESENTED IN GRADES III TO VIII; GIVING THE NUMBER OF CASES, THE MEDIAN IQ, THE RANGE OF THE MIDDLE 50 PER CENT, THE SEMI-INTERQUARTILE RANGE, AND THE TOTAL RANGE OF INTELLIGENCE QUOTIENTS

Group	Cases	Per cent of whole group	Median	Middle 50 per cent	Q	Total range
1. Professional	349	5.07	116	105–130	12.6	70–177
2. Business and clerical	944	14.11	107	94–121	13.5	54–169
3. Skilled	1028	15.38	98	87–111	11.8	54–177
4. Semi-skilled	524	7.84	95	84–107	11.7	53–152
5. Farmer	3098	46.33	91	82–103	10.5	50–161
6. Unskilled	745	11.14	89	77–102	12.5	51–146

TABLE VI.—SHOWING COMBINED OCCUPATIONAL GROUPS REPRESENTED IN HIGH SCHOOL, GIVING THE NUMBER OF CASES, THE MEDIAN, THE MIDDLE 50 PER CENT, THE SEMI-INTERQUARTILE RANGE, AND THE TOTAL RANGE OF IQ

Group	Cases	Per cent of whole group	Median	Middle 50 per cent	Q	Total range
1. Professional.....	201	14.02	121	110–129	9.2	80–167
2. Business and clerical.	374	26.10	112	102–126	12.2	60–168
3. Unskilled.....	54	3.77	111	101–120	9.5	69–139
4. Skilled.....	267	18.63	108	97–125	13.8	78–149
5. Semi-skilled.....	48	3.50	108	101–120	9.5	90–159
6. Farmer.....	489	34.12	106	97–119	11.0	72–155

The outstanding evidence for the existence of a social group based on intelligence is to be found in the median quotient for both professional groups, this being in each case nine points above the next nearest group. It is 27 points above the "unskilled" grade group and in the high school group the excess is 15 points. The order of median quotients in the two groups is practically the same, the one exception being the showing of the unskilled high school group which rises from the sixth place among the grade classes to third place among high schools. The higher selection[1] in the unskilled group partially accounts for this improved showing.

An examination of Fig. 3 will show another evidence of the superiority of the professional class. The line representing this group overlaps only the skilled and the business classes. Even here it is shown that almost 75 per cent of the professional group is superior to all but the upper 50 per cent of the business class and to all but the best 25 per cent of the skilled group, its nearest competitors. As compared with the children of unskilled fathers, the children of professional fathers constitute an almost discrete group, only the very dullest of them scoring so low as the median of the farmer group and only the very brightest of the unskilled class being so intelligent as the median of the professional class.

That some overlappings do occur is, however, a significant fact. Each of the six classes is represented by a number of very dull children, although the dullest child in the professional class has a quotient of 70

[1] The percentages of the several high school groups in terms of the grade groups are as follows: Professional 57, business 36, skilled 25, semi-skilled 9, farmer 15 and unskilled 7.

which is 16 points above the dullest child in the business group. An intelligence quotient of 70 is in the definitely feeble-minded class. The amount of feeble-mindedness in each of the several groups may be seen in Tables VII and VIII for the grades and high school groups respectively. Below the level of 80 the professional class shows only .6 per cent which is only one-tenth the percentage of the business and clerical groups and only one-thirtieth the amount in the unskilled group. Below the level of 70 the professional class shows not a single case, whereas nearly 14 per cent of the unskilled group fall here and each of the other classes has an appreciable percentage of 2 or more definitely below the 70 level.

The comparisons at the opposite end of the scale are equally significant. Twenty-five per cent of the professional group have an intelligence quotient of 120 or higher while only 12 per cent of the next nearest group rise to this level. In the "unskilled" and "farmer" groups there are 1.1 and 2.4 per cent respectively of this grade. The selective character of the high school changes the figures for these children but the same general relation prevails here as in the grade data. If one were selecting the best 5 per cent in either group, the children would be largely from professional fathers while the dullest 5 per cent would be largely from the unskilled class.

This is not the place to enter a detailed discussion of the educational provisions which the data here presented imply, except to note that an adequate educational program should neither obscure nor ignore such differences as are here brought to light. The fact that the findings of the New York data support those of Terman, Book, Pressey and others, and that these findings in regard to children are directly comparable with the Army results for men engaged in occupations lends them greater value for educational and social engineering. It has been shown that success in intelligence tests argues likelihood of success in the traditional high school and elementary school curriculum; it is here shown that such success in intelligence tests is directly related to the occupations of the fathers. It would seem to follow that the occupation of parents has a direct relation to probable success of children in the American public school. The children of the professional class can master the current curriculum with its emphasis upon conceptual knowledge; the children of the artisan class are much less likely to succeed. That the latter are entitled to a modification of present educational procedures designed to facilitate their progress through the school is a possible inference from these data. Probably it is the correct inference.

TABLE VII.—SHOWING THE PER CENT OF PUPILS, GRADES III TO VIII, BELONGING TO THE VARIOUS OCCUPATIONAL GROUPS AND HAVING INTELLIGENCE QUOTIENTS AT DIFFERENT LEVELS. THE MEDIAN FOR THE TOTAL GROUP LIES WITHIN THE INTERVAL 90 AND 99 MARKED ACROSS THE TABLE BY HORIZONTAL LINES

IQ	Unskilled	Farmer	Semi-skilled	Skilled	Business and clerical	Profes-sional
140 and up	.4	.87	1.15	1.94	6.04	11.75
130–139	1.07	1.61	2.67	3.50	6.78	14.04
120–129	3.22	4.04	4.20	7.59	17.19	17.48
110–119	9.66	9.36	10.31	13.71	17.16	20.63
100–109	12.35	15.88	20.80	19.74	19.92	19.19
90–99	20.81	23.33	22.90	23.63	17.16	10.88
80–89	19.86	22.56	22.33	17.41	11.55	5.44
70–79	18.66	14.72	12.59	8.27	5.08	.57
60–69	10.34	6.00	4.19	3.59	2.01	.00
50–59	3.36	1.93	.95	.58	.01	.00
Total.....	99.73	100.30	100.00	99.96	99.90	99.98

TABLE VIII.—SHOWING THE PER CENT OF HIGH SCHOOL PUPILS BELONGING TO THE VARIOUS OCCUPATIONAL GROUPS HAVING INTELLIGENCE QUOTIENTS AT THE DIFFERENT LEVELS. THE MEDIAN FOR THE TOTAL GROUP LIES WITHIN THE INTERVAL 110–119 MARKED ACROSS THE TABLE BY HORIZONTAL LINES

IQ	Farmer	Semi-skilled	Skilled	Unskilled	Business and clerical	Profes-sional
140 and up	.82	4.00	3.37	.00	4.27	6.46
130–129	3.88	4.00	5.24	9.25	9.36	11.94
120–129	19.22	17.00	21.00	16.66	23.53	33.83
110–119	17.39	16.70	17.60	27.77	17.37	23.38
100–109	25.15	35.50	22.05	24.07	24.86	10.94
90–99	21.68	22.90	22.05	12.96	12.83	8.45
80–89	10.84	.00	7.50	7.40	6.68	3.48
70–79	1.02	.00	1.00	.00	1.07	1.44
60–69	.00	.00	.00	1.85	.00	.00
	100.00	100.0	99.81	99.96	99.98	99.92

A TEST OF PHYSICAL EFFICIENCY

The Correlation between Results Therefrom and Results from Tests of Mental Efficiency

J. L. ENGLEHARDT

University of Kansas

Very little is known concerning the relationship between mental and physical efficiency. Leta S. Hollingworth,[1] says that "Literature on the relation between the physical and mental is very meagre. In no branch of child study is research more needed and at the same time more conspicuously lacking."

Prerequisites to an investigation of this nature are first, satisfactory tests of mental efficiency, and second; satisfactory tests of physical efficiency. Mental tests which have been in use for some time may be considered satisfactory, but tests of general physical efficiency have not been available.

Tests of physical efficiency in use at present are based upon either bodily dimensions (anthropometric measurements) or standard athletic performances. The first type of measurement is not satisfactory for the reason that such measurements do not necessarily have any direct relationship to functional efficiency. The difficulty is well stated by Dr. D. A. Sargent[2] when he writes "While it is true that other things being equal the strength and functional capacity of a part increases with the size of that part, the number of cases where other things are not equal is so numerous that the generalization should be greatly modified. There is in many a man an unknown equation which makes for efficiency which has never been determined and which can only be measured by an actual test. (Dr. Sargent, with this idea in mind, proceeded to develop a physical test which will be referred to later.)

The chief objection to the athletic event as a test of physical efficiency lies in the fact that it is a test of acquired athletic skill; and efficiency in such performances depends as largely upon training and practice as it does upon inherent ability.

In an attempt to avoid the objectionable features of these two types of tests, a test based upon an earlier test by Dr. Sargent has been

[1] Hollingworth, Leta S.: "Psychology of Subnormal Children."

[2] Sargent, D. A.: The Physical Test of a Man. *School and Society*, Vol. XIII, p. 125.

devised for the purpose of this study. Dr. Sargent's test involves a single vertical jump executed for the attainment of height only. The test used by the writer employs the same basic type of performance but makes use of a succession of jumps executed as rapidly as possible over a specified period of 15 seconds thus bringing into consideration, in addition to the height of the jump, the additional factors of speed and endurance in jumping.

The test as proposed does not involve the objectionable features of dependence upon static bodily measurements or acquired athletic skill. That it is free from the first is apparent. That it is also free from the latter is borne out by the results of the investigation which definitely prove that skill in a particular type of athletic or gymnastic event does not assure a high score on the test; neither does lack of skill in a particular athletic event assure a low score on the test. Basket-ball men and boxers who depend largely upon the extensors for their performance, apparently have no advantage over the wrestler whose performance is confined largely to the flexors.

The test should measure the unknown quality—"vim," "vitality," or driving power—which Dr. Sargent believes to be a very essential and significant factor in the composite termed "physical efficiency." In addition to this "unknown equation" the proposed test should measure speed, endurance, motor-coordination, strength, and agility. Experts in physical education consider that the above mentioned factors comprise the objectives of physical education. They are commonly used as a basis for instructors' judgments as to the physical efficiency of men under their instruction. For the purpose of this study, therefore, the criterion of physical efficiency may be defined as general efficiency in the performance of the physical tasks which are comprised in the physical training programs of our schools. Ability to perform these tasks will be to some extent proportional to the time spent in practice and to the degree in which the individual possesses the other factors mentioned above as constituents of physical efficiency.

A recording mechanism was devised, to make possible the study of the results of the experiment.

A headgear was drawn down over the subject's head and an elastic band snapped under the chin. A lug was adjusted to its proper position for the height of each individual by means of a clamp on a cord so that for each subject a marker on the under side of the slide did not begin marking until the subject left the floor. A ring two feet in diameter was marked on the floor directly under a pulley which was

fastened to the ceiling. The subject was instructed as follows: "Stay within the ring while jumping. Jump as high and as fast as you can. Crouch a little, but only enough to relax the muscles of your back and legs. Jump as high as you can but don't stop between jumps. Ready, go! . . . stop!"

The writer insisted upon the swinging of the arms forward as the subject moved upward, and downward as he returned to the floor. In most cases the method of jumping was demonstrated before an entire class. The purpose in insisting upon the arm movement was to put into play all the muscles possible and to standardize the method of jumping.

One cannot intelligently pass judgment upon the merits of the test without an understanding of the mechanical processes involved in the apparatus. The purpose of the whole device was to record the heights of successive jumps on a paper record sheet clamped on the dial.

The paper record sheet is held in place by means of pivot and clamps. After completing one performance the record sheet is removed, and another sheet put in place for the next test. For the purpose of measuring the length of jumps the record sheet is placed over a peg on the table top and the lines measured with an ordinary tape measure. Except for timing and giving instructions the examiner has nothing to do with the operation. The actual test performance covers a period of 15 seconds. The scoring and computing can be done at leisure and require but a few minutes.

For university students the most satisfactory formula for computing the physical index was empirically found to be as follows:

$$\text{Index} = \frac{\text{The sum of the jumps} \times \sqrt{\text{weight}}}{\text{Height of stature}} = \frac{J\sqrt{W}}{H}$$

For junior high school boys the most satisfactory formula was empirically found to be

$$\text{Index} = \frac{\text{The sum of the jumps} \times \sqrt{\text{weight}}}{\text{Age} \times \text{height of stature}} = \frac{S\sqrt{W}}{AH}$$

(The method of arriving at these indices will be explained later. All lengths and heights are in inches, weights in pounds, and ages in years to the nearest birthday.)

Establishing the Validity of the Physical Test

Judgments of physical instructors were the criteria of physical efficiency on the basis of which validation was conducted.

Sixty men from the University of Kansas were given the physical test. From these, 36 men upon whose physical efficiency at least three instructors felt qualified to judge, were selected for use as a basis for the study. The names were printed on checking blanks and sent to nine physical instructors under at least three of whom each man previously had gymnasium instruction. Instructions on the checking sheet read as follows: "Taking as a basis for comparison that group of men in the university whom you consider to be of average physical efficiency, check that one of the five groups into which you would place each man listed, with reference to his physical efficiency." The five groups indicated on the sheet were "inferior," "below average," "average," "above average," and "superior."

This rating of the judges served as a basis for ranking the man, and these rankings were correlated with the rankings derived from the physical test according to the different index formulas used.

The test was also applied to 200 boys from the Lawrence (Kansas) Junior High School. The criterion of physical efficiency in this case was the judgment of a single physical instructor who was at the time director of physical education in the Lawrence public schools and who for various reasons and after careful consideration was selected to act alone in this capacity. The writer realizes that this is not the most satisfactory procedure, but after trial and investigation it was found to be the best available.

From records obtained for 200 unselected junior high school boys and for 36 university men, physical indices were computed by the various formulas included in Table I and each index correlated with the rankings of the judges. The correlations were computated by means of the formula,

$$P = 1 - \frac{6\Sigma D^2}{N(N^2 - 1)}$$

S = Sum of successive jumps in inches
J = Height of a single jump as used by Dr. Sargent
W = Weight in pounds
H = Height in inches
A = Age in years to nearest birthday

It will be noted in Table I that the highest correlation for university students is .793 ± .04. The formula resulting in this correlation is $\frac{S\sqrt{W}}{H}$ therefore it is considered the most satisfactory formula for computing indices of university students.

TABLE I.—SUMMARY OF CORRELATIONS FOR BOTH UNIVERSITY AND JUNIOR HIGH SCHOOL STUDENTS

Judges' rankings for	Indices of physical efficiency							
	Dr. Sargent's test		The revised test					
	$\frac{JW}{H}$	$\frac{JW}{H}$	S	SW	$\frac{SW}{H}$	$\frac{S\sqrt{W}}{H}$	$\frac{S\sqrt{W}}{HA}$	$\frac{S\sqrt{W}}{A}$
University.....	.585 ± .074	.60 ± .07	.70 ± .057	.78 ± .043	.78 ± .043	.793 ± .04		
Junior high school..	.001 ± .1	.10 ± .1	.565 ± .073	....	....	.55 ± .073	.63 ± .062	.53 ± .0765

The table shows the highest correlation for junior high school boys to be .63 ± .062 and the most satisfactory formula, $\frac{S\sqrt{W}}{HA}$. In other words, it is necessary, in the adolescent period, to take the age into consideration. This is what one would logically expect.

Again referring to Table I, the highest correlation resulting from Dr. Sargent's test is .60 ± .07 as compared with .793 ± .04 for the revised test for university students and .10 ± .1 as compared with .63 ± .062 for the revised test for junior high school boys. The Sargent method is fairly satisfactory for the mature boy, but of no value whatever for adolescent boys judging from these correlations. The self-correlation between two applications of the revised test was .71 ± .06 and .76 ± .046 for the university and high school groups respectively.

THE CORRELATION BETWEEN RESULTS FROM MENTAL TESTS AND RESULTS FROM PHYSICAL TESTS

The mental tests employed were the Otis Group Test, the Terman Group Test, the Illinois Group Test, and the Binet Individual Test. School marks for one semester were also used as a measure of mental efficiency.

The correlation between mental ratings, IQ's, AQ's, and school marks on the one hand, and physical test results on the other were all computed by the Pearson Product-moment Formula, $r = \frac{\Sigma XY}{N\sigma x}\sigma y$. The probable error was computed by the formula, $PE = .6745\frac{1 - r^2}{N}$. See Table II for results.

TABLE II.—SUMMARY OF CORRELATIONS BETWEEN MENTAL AND PHYSICAL EFFICIENCY

	Mental ratings				AQ's			School marks	
	Binet	Illinois	Terman	All mental	Reading	Arithmetic	Average	Including physical training	Omitting physical training
Physical scores ...	.02	.20	−.019	.112	.0835	−.103	−.096	.3425	.29
PE.....	± .067	± .074	± .0618	± .052	± .078	± .088	± .078	± .0697	± .087

It is evident from Table II that, with the exception of school marks, there is no marked correlation between physical efficiency as measured by this type of physical test and mental efficiency as measured by any one of the mental tests employed in this study. There was, however, indication of a substantial correlation between teachers' marks and the physical test ratings.

CONCLUSIONS

1. The physical test devised for this study meets the requirements for a sound test of physical efficiency. It has a high correlation with the composite judgment of physical instructors; it has a high self-correlation; and it is applicable to adolescent and post-adolescent boys.

2. Since the physical test used herein has stood the test of applied criteria and since the mental tests employed have stood the test as to reliability in the mental field, findings of this study concerning the relationship between these two phases of human activity—the mental and physical—should be reliable and significant.

3. Findings of this study offer no evidence of any significant correlation between mental and physical efficiency.

4. It is not known definitely just what elements of physical efficiency this physical test does measure. It should be given further trial and investigation for the purpose of determining the extent to which its performance is dependent upon organic, psychological, and motor efficiency, respectively.

5. For such diverse quantities as physical scores and school marks a correlation of .29 is interesting, and suggests the possibility that this test may be useful in predicting probable school success. Further investigation should be undertaken for the purpose of determining the validity of the test for this purpose.

FIXATION-ACCOMMODATION RATES AS FACTORS IN READING

RALPH E. WAGER

Emory University, Ga.

One of the essential elements in effective reading is that of rate. Studies in this field in recent years have shown wide individual variations with respect to it, and have attempted to analyze the factors concerned. In this paper evidence is presented suggestive of a significant relationship between the normal rate of reading and individual fixation-accommodation rates. It was secured in connection with a study previously reported by the writer in this journal.[1]

It will be necessary at this point briefly to state the construction and method of employment of the apparatus used in the investigation. For a more complete account the interested reader may consult the paper to which reference is made above.

Two hard rubber disks were attached to a rod. By means of certain mechanical devices these could be caused to rotate through arcs of 15°. In front of each disk was placed a shield with an opening 1 inch square. Attached to each were paper disks bearing familiar printed words so placed that with every fractional rotation a word appeared back of the opening. The near disk was located from 8½ to 10 inches from the eye of the subject seated before it, and the more distant from 36 to 52 inches, depending upon his visual powers. Between the subject and the near disk was placed a Roemer voice-key so modified as to operate automatically in resetting. By means of electrical contacts, the instant of appearance of a word back of the opening was recorded on a smoked paper attached to two revolving drums electrically driven. The tripping of the voice-key was also recorded. A Jaquet chronometer was used as a means of making a time record in fifths of seconds. Seated before the apparatus, then, the subject was instructed to read the stimulus words as rapidly as he could. The order in which words were to be presented and the manner in which the record was interpreted will be noted below. At this point it is sufficient to state that the purpose of the tests was to cause shifts in the field of regard from one plane to another, thus com-

[1] A Method of Measuring Fatigue of the Eyes. *Journal Educational Psychology*, Vol. XIII, Dec., 1922, p. 561.

pelling rapid adjustments of the fixative and accommodative type. It is to these that attention is here given.

The intermittent movements of the eye in reading are now understood and the time limits of the movements and the pauses between them have been measured for many individuals.[1] We need not refer further to studies in this field. Equally significant are the results of studies on the movements of the eyes in their adjustments to objects of regard in different and the same planes, conducted by Judd,[2] Judd, McAllister and Steele,[3] and McAllister.[4]

From these it appears that in convergence there is an inward and downward movement, in divergence an upward and outward movement of the eyes. In lateral shifts of the field of regard, the two eyes frequently move independently, one often outstripping its mate in arriving at the new point, or over-running it, or falling short of it, so that there is always a series of corrective adjustments on the part of both.

It is commonplace to state that in reading the eyes make a series of pauses in their passage along a line of words; that perceptions take place during the pauses; that the number of fixations, and the extent of the field taken in during each one, differs in individual cases. Rapid readers make, as a usual thing, fewer pauses than do the slow ones. This implies also the fact that the number of words perceived during each fixation is greater in the case of the rapid reader. Rapid readers require a shorter time to complete the fixation, and make fewer of them per line. With respect to all of these elements there are very wide individual differences. To quote from one of the earlier investigators, Schmidt[5] states:

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[1] Dearborn, W. F.: The Psychology of Reading. *Col. Uni. Cont. to Philos. & Psych.*, Vol. XIV, No. 1, 1906.

Schmidt, W. A.: An Experimental Study in the Psychology of Reading. *Supplementary Educational Monograph*, Vol. I, No. 2, 1917.

Buswell, C. T.: An Experimental Study of the Eye-voice Span in Reading. *Sup. Ed. Mono. Sup. Univ. of Chicago.*

[2] Judd: Photographic Records of Convergence and Divergence. *Yale Psychological Studies*, N. S., Vol. I, No. 2.

[3] Judd, McAllister and Steele: Introduction to a Series of Studies of Eye Movements by Means of Kinetoscopic Photographs. *Yale Psychological Studies*, N. S., I, No. 1, pp. 1–16; also *Psych. Rev. Mon. Sup.*, Vol. VII, No. 1, Mr., 1906.

[4] McAllister: The Fixation of Points in the Visual Field. *Yale Psychological Studies*, N. S., Vol. I, pp. 12.

[5] An Experimental Study in the Psychology of Reading. *Supplementary Educational Monograph*, Vol. I, No. 2, 1917.

"Individual variations is strongly in evidence in connection with the results of the present investigation. In fact, it is the most outstanding characteristics, not only in the case of total results in connection with speed and comprehension, but also in case of most of the minor factors." Subsequent studies by Buswell,[1] and by Judd and Buswell,[2] each serve only to bring into clearer perspective the significance of these individual differences. We may then legitimately ask the questions: Why do individuals differ so markedly in the rate at which they normally read? Again: Is the rate of normal reading the product of habit (and training) or, is it in part at least, the result of native characteristics set and determined by physiological factors?

The records made with the apparatus above briefly described enabled one to measure the fixation-accommodation time for each shift in the plane of regard. There is a wide variation in the average of such time for different subjects. For example, subject W showed an average reaction time to two tests of 8.7 and 8.9 (fifths of seconds), while subject B on the same test yielded the average of 4.02 and 6.9 respectively. Similar results were obtained for other subjects.

In connection with one of their university courses many of our subjects had made a determination of their reading rate. In considering the resulting ranking, it was noted that those who, in our tests, manifested a short average fixation-accommodation time tended to rank high in the series, and those who, on the other hand, manifested relatively long fixation-accommodation-time tended to rank low in the series. This fact suggested that in the normal fixation-accommodation time might be found a possible explanation for differences in normal rates of reading. To test the hypothesis the small body of evidence was accumulated which is to be presented.

As already noted, the rapidly succeeding movements and intervening pauses in the act of reading are of necessity due to muscular adjustments. If we were to assume that for every fixation-accommodation pause, in addition to the coarser movements such as are involved in carrying the eyes along the line of words, there were involved also a distinct adjustment both of the internal and external musculature of the eyes, we should then be in position to make a further step in the argument: that the native muscular reaction-time of any individual must of a necessity be a factor in fixing his reading rate. Now there

[1] Fundamental Reading Habits: A Study of Their Development. *Supplementary Educational Monograph* No. 21, University of Chicago.

[2] Silent Reading: A Study of the Various Types. Pp. XIV + 160. *Supplementary Educational Monograph* No. 23, University of Chicago.

are evidences that such muscular readjustments do take place in connection with each fixation pause; that reading consists of a series of such rapid but necessary adjustments in connection with each such pause in order that perception may take place. The adjustment must be preliminary to perception. The evidence may best be presented by making a quotation.

Schmidt discovered on his records, evidence upon which he based the following statement: "On the whole, the foregoing phenomena point strongly to the conclusion that rapid movements of the eyes, such as are involved in the return sweep and the inter-fixation movements, are accompanied by divergent adjustment, and that this is followed by a convergent adjustment during the subsequent fixation pauses. As far as the horizontal plane is concerned the eyes move outward during the divergence—the two eyes moving, of course, in opposite directions; during convergence the directions are reversed, the eyes moving in this case inward. As a matter of fact, this adjustment, both divergent and convergent, is comparatively slight after the initial fixation pause, so slight that at times it is scarcely perceptible. There are, moreover, marked individual differences. There is no reason to believe, however, that these forms of adjustments are absent. A critical examination of more than 200 records show no exceptions, at least so far as divergence is concerned."[1]

Thus, there is basis for assuming that in the act of reading there takes place a succession of fixations (and hence of accommodations) as preliminaries to perception. It is apparent also that individuals differ with respect to the number of such fixations per line and hence also the span or width in the field of regard. If then in each line there be made a number of separate muscular adjustments, in fixations and accommodations, it would seem evident that, since adjustments require time for their consummation, they would of necessity be highly significant in determining the total time occupied in the reading act. Furthermore, since it is well known that muscular reaction-times vary largely in different individuals, it would seem equally obvious that variations in reading rates might well be due in part at least to individual differences with respect to the time required for the muscular adjustments demanded. That there are other factors significantly involved, this position does not deny. It seeks only to call attention to the fact that the fixation-accommodation act is a time consuming

[1] An Experimental Study in the Psychology of Reading. *Supplementary Educational Monograph*, Vol. I, No. 2, 1917, pp. 97–98.

one and hence must receive attention in any effort to interpret individual variations in rate of reading.

Attention was called above to the fact that those subjects with short fixation-accommodation time tended to rank high in reading rate. Another class later made a determination of the average reading rates of its members on the basis of which a ranking was made. Two members exhibiting the more rapid rates, two from the median group, and two from the lower end of the series, were given our tests for the purpose of determining their average fixation-accommodation-times. Although the number thus serving as an experimental basis is not large, nevertheless the manner in which they were selected gives significance to the conclusion based thereon.

Subjects Mc and L were at the upper end of the series in the order named. P and Z were at the lower end, likewise in the order named. W and Sh were near the median of the series, Sh ranking several places below W and thus about mid-way between the median and the lower end of a group of some thirty-five cases. The test employed was the 2-1 type which will be described below. Each subject was given preliminary training in the manner of responding to the stimuli and adjusting himself to the needs of the apparatus employed. Two of the 2-1 tests were given to each subject and the average fixation-accommodation times determined. For the subjects above identified these were:

Mc	3.8	Sh	5.6
L	4.2	P	5.2
W	5.2	Z	6.0

It is clear that the rankings are highly suggestive. Subject Sh exhibits a longer average reaction-time than P, although he stood above him in reading rate. With this exception, the ranking in reading rate corresponds fully with that based on fixation-accommodation times.

In order that the accompanying record may be understood a brief account of the manner in which the tests were given is necessary.

Recall the fact that two stimulus disks were employed at different distances from the eyes of the subject. In the 2-1 test 24 words were used on the distant disk so that with each fractional rotation one appeared behind the opening; on the near disk but twelve words were employed, each alternate rotation bringing a blank behind the opening. In applying the test a word appeared in the distant opening, the near one being blank. Perception of the distant stimulus was followed by a partial rotation which brought a word behind each opening. The distant one was then read and an immediate shift in the field of regard

took place for the purpose of reacting to the near one. Another fractional rotation restored the original condition, after which the process was repeated until the complete series had been run off. Reference to the records reproduced in the accompanying figure are to be interpreted as follows: In series 2, A′ marks the registration of the instant of response to the distant stimulus; 1, the record of the shift of the disks bringing the new stimulus words back of the opening; B′ the reaction to the distant and C′ to the near words; 2, following the partial rotation bringing a word back of the opening in the distant plane; A″, the reaction to it; 3, the following shift in stimulus words; B″ and C″ the reac-

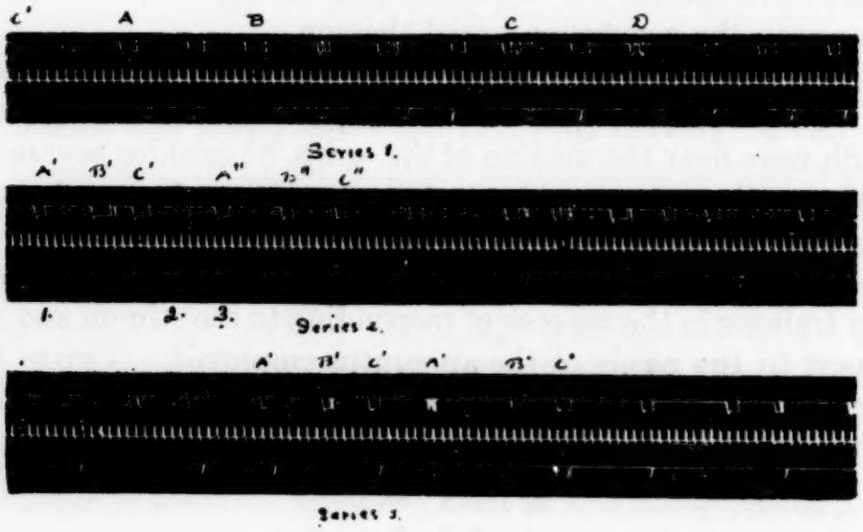

Fig. 1.

tions thereto, and so on. Between the records of response and stimulus shifts is the time record in fifths of seconds. By projecting the record of the instant of appearance in the stimuli and the responses thereto, against this time-record, it is easily possible to determine the intervals required by each subject to make each adjustment.

The three records in Fig. 1 deserve attention. Series I was made by subject Mc, whose reading rate was very high. It will be noted that the fixation-accommodation time required in connection with the shifts in the field of regard from distant to near plane (B′ and C′) is very short. In some cases it was so short as to make the recording of the two responses impossible, due to the "drag" on the marker. As a result several of the paired responses are recorded as one, as at A and B. Careful observation was made during the test to make sure that this

interpretation was correct. By setting the marker so that it bore less heavily on the smoked paper, the separate responses were obtainable. In such procedure, however, the uneven surface of the drum caused indistinct lines to be made by the pointer, and the advantage was thus lost.

Comparison of the records of subject Mc (Series I) and subject W (Series II) suffices to illustrate the evident differences in accommodation-fixation time. Subject W ranked in the middle section of the series in reading; Mc, it will be recalled, was at the head of the list. The adjustments as made by W are uniformly longer than those made by Mc. Similarly, the record of Sh (Series III) shows uniformly longer periods than either of the others. Subject Sh was a slow reader. It is unnecessary to comment further on the records. The averages cited above typify and serve to make their relationships easily understood.

Although the cases investigated are not sufficiently numerous to justify a sweeping generalization from the evidence they furnish, nevertheless, the facts above cited are significant. There appears to be some basis for the assumption that between normal reading rate and fixation-accommodation time there exists an intimate relationship. It is not to be understood, however, that the muscular elements are alone concerned. That there are important central adjustments is also to be taken into account. Undoubtedly there are sufficiently marked differences in the rates at which the apperceptive processes take place to play a conspicuous part in the factors conditioning the normal reading rate. However, it is likely that the fixation-accommodation rate, under the usual conditions of reading, is probably the grossest element and therefore to be regarded as highly important.

We may at this point return to a consideration of the first group of subjects, whose reaction-times were compared with a ranking based on reading rates. Through the kindness of Dr. G. T. Buswell five of these were subjected to the photographic method for the determination of ocular movements in reading. In this method very accurate timing is possible so that the duration of each movement or pause is determinable. From a compilation of the number of pauses made, and the time of each, it was possible to compute the average pause-time. Measured in twenty-fifths of seconds, the rapid reader of the groups (and not the most rapid reader in the class of which these subjects were a part) had an average pause-time of 6.5; the slowest averaged 10.1; a middle group reader averaged 7.4.

The points above made may also be considered in connection with another aspect of the problem. Dr. Quantz[1] in investigating the conditioning factors of reading, found that the visual type was superior to the auditory; that motor-mindedness, as evidenced by lip-movement, was likewise a hindering factor. Dearborn[2] while admitting that "a new fixation is made for each unit of perception" (p. 131) finds the causes for differences in rates in the habits of regularity of movement and extent span. However, he notes also that "An important cause of slow reading may be, for example, the excess auditory-motor accompaniment of repressed articulation, etc., which is only another way of saying that the assimilative processes are slower. The effect of articulating is itself to decrease ordinarily the span of attention, and therefore, as argued, make the duration of all pauses uniform" (p. 121).

Our results indicate that it is not altogether the mere act of articulation which functions as a differentiating factor since in our test articulation accompanied each perception. It is possible, however, to look upon articulation (either completed or inhibited) as highly significant if it be regarded as itself conditioned in rate by native muscular-reaction time. If so regarded, it is evident that two muscle groups are involved—the ocular and the vocal, and the muscular reactions attending each are time-consuming and must affect as a consequence the rate at which oral reading (or inhibited vocalizations for that matter) can be accomplished.

Furthermore, if the act of inward speech, which may be regarded as a semi-inhibited motor response, be in reality a factor in determining the reading rate, then Dearborn's contention that its effect is manifested in a shortening of the span of attention by increasing the time of assimilation, might be accepted, but with the added implication that the effective factor is the time element involved in the motor responses, even though largely inhibited.

Not only so, to push the point further; it is difficult to see how, in our test, the attention span might be a significant factor since there was involved but one word, and it very familiar. That the central elements were highly involved seems also to be eliminated since the conditioning stimulus was a word so familiar as to bring a response quite automatically. Indeed, it is thinkable that this played a very

[1] Quantz, J. O.: Problems in the Psychology of Reading. *Psych. Rev. Mon. Sup.*, Vol. II, No. 1.

[2] Dearborn, W. F.: The Psychology of Reading. *Col. Univ. Cont. to Philos. & Psych.*, Vol. XIV, No. 1, 1906.

minor part in producing the differences. It is admitted, as above pointed out, that there are undoubted individual variations in the rate at which the associative processes complete themselves, but it does not seem admissible that in these variations alone may be found the causes for the wide differences in the reactions as we have described them.

Our results throughout emphasize the conclusion that differences in motor-reaction times are apparently to be regarded as significant factors in reading rates. So regarded, speed in reading is not an outcome of habit alone, or of the size of the attention-span alone, but rather of a complexity of factors of which muscular-reaction-time is not the least. Reading rates have physiological limitations.

It is not to be inferred from the above that the position here taken denies the validity of the contention that proper habits of rhythmic movements and a wide attention-span are impossible of acquisition through training, as such a conclusion does not follow from our interpretation. It is desired, however, to lay emphasis upon the fact that there are undoubted native physiological limitations placed upon each individual by virtue of which bounds are set for him with respect to the maximum rate at which he may make the necessary muscular adjustments involved in reading. Recognition of this fact makes proper training the more important.

Summary

In this paper the following points have been made:

1. Individuals differ greatly with respect to rate of reading.
2. Individuals differ greatly with respect to average fixation-accommodation-times involved in a shift of the field of regard from a more distant to a near plane (or vice versa).
3. Those subjects who rank high in reading rates exhibit a short average fixation-accommodation time, and those who possess a slow reading rate tend to exhibit longer fixation-accommodation times.
4. Although admitting the significance of central reactions the conclusion from our evidence seems warranted that native differences in muscular reaction-times as exhibited in fixation-accommodation adjustments are determining factors in reading rates.

FORMULAS FOR FACILITATING THE COMPUTATION OF THE MEAN OF THE DISTRIBUTION OBTAINED BY COMBINING COMPONENT DISTRIBUTIONS

M. R. NEIFELD

Columbia University

If a distribution D_1 consists of N_1 observations of a variable X, and if a distribution D_2 consists of N_2 observations of the same variable, then we can express the mean of the combined distribution D_{12} (which is made up of the two component distributions D_1 and D_2) in terms of the means M_1 and M_2 of the component distributions. For if we denote the values in D_1 by X_1 and in D_2 by X_2, we have

$$\Sigma(X) = \Sigma(X_1) + \Sigma(X_2) \text{ and}$$
$$N \cdot M = N_1 \cdot M_1 + N_2 \cdot M_2 \qquad (1)^1$$

where $N = N_1 + N_2$.

Now, suppose that $A = \frac{N_1}{N_2}$, then $N = N_1 + \frac{N_1}{A}$, and $N = \frac{N_1(A+1)}{A}$.

Substituting in (1)

$$M = \frac{N_1 \cdot M_1 + \frac{N_1 \cdot M_2}{A}}{\frac{N_1(A+1)}{A}}$$

$$M = \frac{A \cdot N_1 \cdot M_1 + N_1 \cdot M_2}{N_1(A+1)}$$

$$M = \frac{A \cdot M_1 + M_2}{A+1} \qquad (2)$$

Now let $M_2 = M_1 + d$ and substitute in (2)

$$M = \frac{A \cdot M_1 + M_1 + d}{A+1} = \frac{M_1(A+1) + d}{A+1}$$

$$M = M_1 + \frac{d}{A+1} \qquad (3)$$

In other words, the mean of a combined distribution is equal to the means of one of the component distributions increased by the algebraic quantity obtained by dividing the difference of the means of

[1] Yule, G. V., "Theory of Statistics." 6th ed., p. 115.

the two component distributions by the ratio of the populations of the two component distributions increased by unity.

This formula enables one to predict what part the size of the two populations will play in the shift in the value of the mean. In addition, since in reality there are only three unknowns in equation (3), any two being given, the third can be found. This enables us to find the mean of the remaining population when we know the mean and the population of a series and of a sub-series.

It is worth while calling attention to a number of special cases. If $A = 1$, *i.e.*, if the populations of D_1 and D_2 are equal, then the mean of D_{12} will be midway between M_1 and M_2. If the population of D_1 is infinite, then A becomes infinite and $M = M_1$; and if N_2 is infinite A becomes zero and M becomes infinite in value (unless d is also zero, which means the same as the preceding case, namely, that the mean of the infinite population is the same as that of its infinite part). These two cases simply call attention to the fact that unless we are dealing with two finite distributions, all our arithmetic breaks down. For the same reason it follows that A cannot be negative nor irrational.

The relation expressed by (3) can readily be generalized as follows: If there are n series of observations $X_1, X_2, X_3, \ldots X_1$, the mean M of the whole series is related to the means $M_1, M_2, \ldots$ of the component series by the equation

$$N \cdot M = N_1 \cdot M_1 + N_2 \cdot M_2 + N_3 \cdot M_3 + \ldots + N_n \cdot M_n \qquad (4)$$

Now suppose $\frac{N_1}{N_2} = A_1, \frac{N_1}{N_3} = A_2, \ldots, \frac{N_1}{N_n} = A_{n-1}$

Then $$N = N_1 + \frac{N_1}{A_1} + \frac{N_1}{A_2} + \ldots + \frac{N_1}{A_{n-1}} \quad \text{or}$$

$$N = N_1\left(1 + \frac{1}{A_1} + \frac{1}{A_2} + \ldots + \frac{1}{A_{n-1}}\right)$$

Substitute in (4)

$$M = \frac{N_1 \cdot M_1 + \frac{N_1 \cdot M_2}{A_1} + \frac{N_1 \cdot M_3}{A_2} + \ldots + \frac{N_1 \cdot M_n}{A_{n-1}}}{N_1\left(1 + \frac{1}{A_1} + \frac{1}{A_2} + \ldots + \frac{1}{A_{n-1}}\right)}$$

Let $B = \frac{1}{A}$, then

$$M = \frac{N_1 \cdot M_1 + B_1 \cdot N_1 \cdot M_2 + B_2 \cdot N_1 \cdot M_3 + \ldots + B_{n-1} \cdot N_1 \cdot M_n}{N_1(1 + B_1 + B_2 + \ldots + B_{n-1})}, \text{ or}$$

$$M = \frac{M_1 + B_1 \cdot M_2 + B_2 \cdot M_3 + 1 \ldots + B_{n-1} M_n}{1 + B_1 + B_2 + 1 \ldots + B_{n-1}} \qquad (5)$$

Let $M_2 = M_1 + d_1$, $M_3 = M_1 + d_2$, . . . $M_n = M_1 + d_{n-1}$

Substitute in (5)

$$M = \frac{M_1 + B_1(M_1 + d_1) + B_2(M_1 + d_2) + \ldots + B_{n-1}(M_1 + d_{n-1})}{1 + B_1 + B_2 + \ldots + B_{n-1}}$$

Rearranging, $M =$

$$\frac{(M_1 + B_1 \cdot M_1 + B_2 \cdot M_2 + \ldots + B_{n-1}M_1) + (B_1d_1 + B_2d_2 + \ldots + B_{n-1}d_{n-1})}{1 + B_1 + B_2 + \ldots + B_{n-1}}$$

Simplifying, $M = M_1 + \dfrac{B_1d_1 + B_2d_2 + \ldots + B_{n-1}d_{n-1}}{1 + B_1 + B_2 + \ldots + B_{n-1}}$

or $$M = M_1 + \frac{\Sigma B_m d_m}{1 + \Sigma B_m} \text{ where } m = 1, 2, \ldots, n_{-1} \qquad (6)^1$$

When $$B_2 = B_3 = B_4 = \ldots = 0$$

$$M = M_1 + \frac{B_1d_1}{1 + B_1} = M_1 + \frac{\frac{d_1}{A_1}}{1 + \frac{1}{A_1}} = M_1 + \frac{d_1}{A + 1}$$ which is the special case of two component series given by equation (3).

A slightly different formula can be obtained by letting

$$A = \frac{N_1}{N},\ N_1 = AN \text{ and } N_2 = N - N_1 = N - AN = N(1 - A)$$

Then $$M = \frac{A \cdot N \cdot M \cdot + N(1 - A)M_2}{N} M = A \cdot M_1 + M_2 - A \cdot M_2;$$

$$M = -A \cdot M_2 + M_2 + A(M_2 - d);\ M = -A \cdot M_2 + M_2 + A \cdot M_2 - Ad\ M = M_2 - Ad \qquad (7)$$

For the general formula we have

$$A_1 = \frac{N_1}{N}, A_2 = \frac{N_2}{N}, A_3 = \frac{N_3}{N}, \ldots, A_n = \frac{N_n}{N}$$

Since $$N = N_1 + N_2 + N_3 + N_4 \ldots + N_n$$

$$N = N \cdot A_1 + N \cdot A_2 + N \cdot A_3 + \ldots + N \cdot A_n \text{ or}$$

$$N = N(A_1 + A_2 + A_3 + \ldots + A_n) \text{ and}$$

$$A_1 + A_2 + A_3 + A_4 + \ldots + A_n = 1$$

Then $$N \cdot M = A_1 \cdot N \cdot M_1 + A_2 \cdot N \cdot M_2 + A_3 \cdot N \cdot M_3 + \ldots + A_n N \cdot M_m$$

$$M = A_1M_1 + A_2M_2 + A_3M_3 + A_4M_4 + \ldots + A_nM_n \cdot \textit{ i.e.}$$

$$M = \Sigma A_m M_m \qquad (8)$$

---

[1] The arithmetic of calculation can be reduced somewhat by remembering that since $B_{n-1} = \frac{1}{A_{n-1}}$ and since $A_{n-1} = \frac{N_1}{N_n}$, then $B_{n-1} = \frac{N_n}{N_1}$.

Also if we

Let $d_1 = M_2 - M_1$, $d_2 = M_2 - M_3$, . . . , $d_{n-1} = M_2 - M_n$

Then $M = A_1(M_2 - d_1) + A_2M_2 + A_3(M_2 - d_2) + \ldots + A_n (M_2 - D_{n-1})$

$M = M_2(A_1 + A_2 + \ldots + A_n) - A_1d_1 - A_3d_2 - \ldots - A_nd_{n-1}$

$M = M_2 - A_1d_1 - A_3d_2 - A_4d_3 - \ldots - A_nd_{n-1}$

or $M = M_2 - A_1d_1 - \Sigma A_md_{m-1}$ (9)

where $m = 3, 4, \ldots, n.$

These formulas enable us to predict the amount of change in the mean of a distribution when one or more component series are either subtracted from or added to the entire distribution. They simplify the arithmetic by reducing the size of the numbers used in the calculations; and it is not necessary to have the actual numbers in the various populations. The populations expressed as percentages can be used in the formulas.

A FURTHER NOTE ON THE WHOLE AND PART METHODS

H. B. REED

Grinnell College

After referring to 10 contributors to the whole and part methods of learning Warner Brown concludes his paper with the statement: "Of the 10, Reed and Pechstein are the only ones who themselves dispute the advantages of the whole method or whose data are unfavorable to the whole method." (This Journal, Vol. XV, p. 233.) I have looked over the literature again and find that the situation is not nearly so favorable. With respect to conclusions there is at least a third one, Ephrussi, who does not find the whole method favorable for learning pairs of syllables or of Russian-German vocabularies. With respect to data, the situation is much less favorable to the whole method. At least six of the contributers find data in favor of the part method—Ebert and Meumann, Ephrussi, Larguier des Bancels, Pechstein, Pentschew, and myself. This disagreement between facts and conclusions is due in part to a lack of clearness in the meaning of economy and in part to a disagreement as to how it should be measured. One method may be most economical for learning, and another for relearning, and a third for retention if that is measured by the Saving Method. Which method is the most economical when you consider these factors?

Suppose that by Method A I spend 10 minutes in learning a piece and four minutes in relearning it next day. According to the Saving Method I retained 60 per cent. Suppose that by Method B I spend six minutes in learning another piece of equal length and difficulty and that it requires three minutes to relearn it the next day. If we base our judgments on the Saving Method, then Method A is the more economical for retention. But this strikes us as a falsity, for Method A required four minutes longer in the learning and one minute longer in the relearning. The reason that it gives a larger percentage retained is that it required so long to learn. The results obtained by the Saving Method depend upon the relative differences between the times compared. It cannot be used for measuring the comparative efficiency of two methods, for it ignores the amount of work per unit of time.

Meumann says that the whole method is the best for retention because it yields the largest percentage as measured by the Saving

Method, but if this method is unreliable then his judgment is groundless.

Efficiency is ordinarily measured by the amount of work or output per unit of time. If we use this measure for comparing the efficiency of two methods for retention, then we must consider that here are two pieces of work to be done, learning and relearning. That method is the most economical for retention which enables the learner to do both in the least time. Let us apply this criterion to the results of Ebert and Meumann.

Methods	A Whole	B Part	C Mixed	D Mixed
Average number of repetitions to learn.....	10.5	9.2	7.9	9.4
Average number of repetitions to relearn...	4.4	4.7	4.1	4.4
Sums.....	14.9	13.9	12.0	13.8

Here we see that the whole method makes the poorest showing when both learning and relearning are considered. If we look at the results for the learning we see that it also makes the poorest showing there. The C Method, which I called a modified part method because the learner learned in groups of four syllables, is the shortest both for learning and for relearning. My repetition of this experiment showed the same results, namely that of these four methods the A Method is the longest and the C Method is the shortest both for learning and for relearning. With respect to Ebert and Meumann we can say that although their conclusions favor the whole method, yet the facts, both of their experiment and of my repetition of it do not favor it.

Shall we measure economy in learning by time or repetitions? Dr. Brown states that my experiments contain the defect that no account was taken of the number of repetitions. Repetitions are not a reliable measure because their number is influenced by the rate of reading and their duration is influenced by the length of the piece learned. Repetitions are thus a variable unit and are insignificant if efficiency is measured by number of words per unit of time. They may be used only when they have constant time values as in learning equal rows of nonsense syllables at a constant rate. If both measures are used and the two disagree, then I think it is better to base our judgments on the time values. For this reason I interpret many of the results found by Pentschew as in favor of the part method.

Brown does not think that the sample which I gave from Pentschew is truly representative. If I estimate his results by experimental series I get the following: He made 25 series. Ten made with adults

using syllables favor the whole method. Five made with children using syllables favor the part method. Three out of five made with adults using poetry favor the part method as measured by time. Three out of five made with children using poetry favor the part method as measured by time. Pentschew thus found the whole method the most economical only for adults using syllables. For meaningful material the part method was the most economical for both adults and children. The part method was the more economical in all experiments with children using syllables. Practically half of his data favor the part method, but all of his conclusions favor the whole method.

Larguier des Bancels made five series of experiments on the part and whole methods. Of these two favor the part method.

Lakenan made three series of experiments using two adults and seven children. In the first series one of the adults found the part method the quickest in learning. In the second experiment the same subject generally found the whole method the quickest. She found the whole method generally the most favorable for retention. Two of the children found the part method the quickest in learning and three of them found it the most favorable for retention.

If we view the results on the part and whole method with respect to the number of contributors we must count the data obtained by Ebert and Meumann, Ephrussi, Pechstein, Reed, and a large proportion of those by Larguier des Bancels and Pentschew in favor of the part method. This leaves four and in addition the new data supplied by Brown in favor of the whole method. This arrangement is at least sufficient ground for calling in question the almost universal endorsement of the whole method by educational authorities. But I think that a much sounder judgment is reached if we consider the number of subjects from whom the results were obtained than the number of contributors.

I have gone through the literature available and counted as accurately as possible the number of subjects used by each experimenter. I obtained the following results:

Author	Number of Subjects Used
Brown	
Ebert and Meumann	5
Ephrussi	13
Lakenan	9
Larguier des Bancels	8
Neumann	
Pechstein	36
Pentschew	11
Pyle and Snyder	1
Reed	128
Steffens	9

Brown does not give his number of subjects and Neumann's monograph I could not find. It is interesting to notice that the authors favoring the whole method use a very small number of subjects. Their results could easily be due to the accident of individual variations, and as I pointed out in my previous paper no general law can be deduced from such a small number of subjects. Although only three of the above 11 authors favor the part method, their conclusions are based on the results of a total of 177 subjects. The authors favoring the whole method used a total of only 43 subjects plus those used by Brown and Neumann. As pointed out above, a critical survey of the findings of these authors shows that many of their facts are at variance with their conclusions and are in favor of the part method. I do not regard the question as settled but I think two things must be clear: (1) Conclusions based upon the results obtained from 177 subjects are not easily invalidated. (2) The almost universal endorsement of the whole method by educational authorities is quite unwarranted.

I hope some one will be inspired to make a long and extensive research, the results of which will enable us to come to an agreement.

THE VERIFICATION OF GROUP EXAMINATIONS[1]

JOHN P. HERRING

Director, Bureau of Research, New Jersey Department of Institutions and Agencies

To administer group tests of intelligence and then verify extreme and crucial cases by administering individual tests of intelligence is advised with a frequency which merits scrutiny. The assumptions and tables following show analysis of the amounts and frequencies of errors of estimate in examining with various degrees of unreliability and indicate what proportion of the measurement needs to be done all over again with individual tests in view of the degree of unreliabity of whatever instruments were first used.

It is assumed that each child subject to reclassification and other treatment based upon intelligence measurement should be precisely measured; that the degree of precision should be ascertained; and that the conventional criterion of certainty, three times the standard error of estimate, is valid. The word *certain* in this article always refers to this criterion.

For illustration a school class is divided in two at a point which is 1 σ from the mean, or in three at two points each 1 σ from the mean. Table I then shows, for various degrees of unreliability of measurement, the number of children per thousand mismeasured[2] by 2, 4, 6, . . . 84 mental months. Table II then shows for various degrees of unreliability of measurement, the number of children per hundred who are not certain to fall on the right side of a line of division.

The number, n, of errors of estimate equalling or exceeding a given amount, m, is by definition $n = 2\left[1 - \tfrac{1}{2}(1 + a)_{\frac{m}{\sigma_1 k}}\right]$ in which n, in the body of the table, is the number of errors of estimate equalling or exceeding m; m, the minimum error of estimate in any n, is here 2, 4, 6, . . . 48 mental months.

$\tfrac{1}{2}(1 + a)$ is a Gaussian area (Table II of Pearson's Tables for Statisticians and Biometricians) corresponding to fractional standard deviations (x) taken from the mean of the errors of estimate whose σ is $\sigma_1 k$. In Pearson's Table II x is given to two decimal places only.

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[1] Prepared under the auspices of the Division of Education and Classification, William J. Ellis, Director.

[2] The term *mismeasured* is defined in the sub-title of Table I.

TABLE I.—NUMBER PER THOUSAND MISMEASURED

Values of n, the number per thousand having errors of estimate equalling or exceeding two months, four months, etc., for magnitudes of k corresponding to r

r	k	2	4	6	8	10	12	18	24	30	36	42	48	60	72	84
1.00	.00	0	0	0	0	0										
.99	.14	549	234	73	17	3	0									
.98	.20	674	407	211	95	38	12	0								
.97	.24	726	490	298	168	82	38	2	0							
.96	.28	764	549	373	234	136	73	7	0							
.95	.31	787	589	418	280	180	107	16	1	0						
.94	.34	803	624	459	327	219	142	27	3	0						
.93	.37	818	653	497	368	258	177	42	7	0						
.92	.39	834	667	522	395	285	201	55	10	1	0					
.91	.41	841	682	542	418	308	222	67	15	2	0					
.90	.44	849	704	569	447	342	254	89	23	5	1	0				
.89	.46	857	719	589	472	363	276	103	30	7	1	0				
.88	.47	857	726	596	478	373	289	110	33	8	1	0				
.87	.49	865	734	610	497	395	308	126	41	11	2	0				
.86	.51	873	741	624	516	412	327	142	50	14	3	1	0			
.85	.53	873	757	638	529	430	347	156	59	18	5	1	0			
.84	.54	881	757	646	535	441	352	165	64	21	5	1	0			
.83	.56	881	764	653	549	459	373	180	73	26	7	2	0			
.82	.57	881	772	660	562	465	379	187	80	29	9	2	0			
.81	.59	889	779	674	575	478	395	204	91	34	11	3	1	0		
.80	.60	889	779	674	575	490	407	211	95	38	12	4	1	0		
.75	.66	897	803	704	610	529	447	254	129	59	23	8	2	0		
.70	.71	904	818	726	638	555	484	289	159	78	35	14	5	0		
.65	.76	912	826	741	660	582	509	322	187	101	49	21	9	1	0	
.60	.80	920	834	757	674	603	529	347	211	119	60	29	12	2	0	
.50	.87	920	849	772	704	631	569	390	250	150	85	44	21	4	1	0
.40	.92	928	857	787	719	653	589	412	276	174	103	57	30	7	1	0
.30	.95	928	857	795	726	660	596	430	294	187	114	66	35	9	2	0
.20	.98	928	865	795	734	667	610	441	308	201	126	73	41	11	2	0
.10	.99	936	865	803	734	674	610	447	312	208	129	77	43	11	2	0
.00	1.00	936	865	803	741	674	617	453	317	211	134	80	46	12	3	0

The conclusions do not rest for their validity upon tabled values of n obtained by interpolation for values of x lying between successive hundredths.

σ_1 is 24 mental months, the approximate σ of a 12-year-old age group.

TABLE II.—PER CENT NEEDING REMEASUREMENT

Values of P_1 and P_2 for values of k corresponding to values of r

r	k	$\sigma_2 = 4$		$\sigma_2 = 8$		$\sigma_2 = 12$		$\sigma_2 = 16$	
		P_1	P_2	P_1	P_2	P_1	P_2	P_1	P_2
1.00	.00	00	00	00	00	00	00	00	00
.99	.14	94	100	59	98	40	81	30	61
.98	.20	100	...	79	99	57	97	43	86
.97	.24	...	...	88	100	66	99	51	96
.96	.28	...	...	94	...	75	99	59	98
.95	.31	...	...	96	...	80	100	65	98
.94	.34	...	...	98	...	85	...	70	99
.93	.37	...	...	99	...	89	...	74	99
.92	.39	...	...	99	...	91	...	77	99
.91	.41	...	...	100	...	93	...	80	100
.90	.44	...	...	...	...	95	...	84	
.85	.53	...	...	...	...	99	...	92	
.80	.60	...	...	...	...	100	...	96	
.70	.71	...	...	...	...	...	...	99	
.60	.80	...	...	...	...	...	...	100	

Table II shows values of P_1, the per cent needing remeasurement when Gaussian groups having σ's of 4, 8, 12, or 16 mental months are divided in two (Case 1) at a point 1 σ from the mean, and of P_2, the percentage needing remeasurement when such groups are divided in three (Case 2) at two points each 1 σ from the mean.

The percentage needing remeasurement in Case 1 is by definition

$$P_1 = \left[\tfrac{1}{2}(1+a)_{\left(\frac{3\sigma_1 k}{\sigma_2} - \frac{x}{\sigma_2}\right)} - .5 \right] + \left[\tfrac{1}{2}(1+a)_{\left(\frac{3\sigma_1 k}{\sigma_2} + \frac{x}{\sigma_2}\right)} - .5 \right] \quad (1)$$

$P_1 = b + c$, in which b and c are the first and second terms respectively of the second member of (1).

By definition

$$P_2 = 2P_1 \text{ when } \left(\frac{3\sigma_1 k}{\sigma_2} - \frac{x}{\sigma_2}\right) \text{ is 0 or negative.}$$

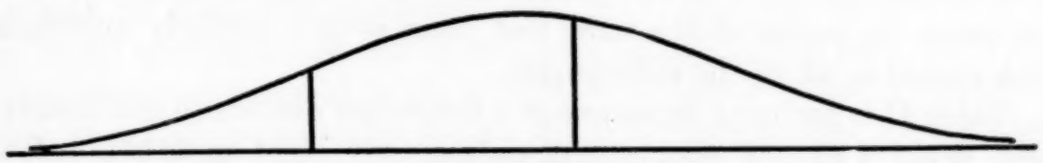
By definition

$$P_2 = 2c \text{ when } \left(\frac{3\sigma_1 k}{\sigma_2} - \frac{x}{\sigma_2}\right) \text{ is positive.}$$

Graph for Table I.

$[\frac{1}{2}(1 + a) - .5]$ is an area (Table II, Pearson's Tables for Statisticians and Biometricians) corresponding to values of x. $[\frac{1}{2}(1 + a) - .5]$ has the sign of $\left(\frac{3\sigma_1 k}{\sigma_2} - \frac{x}{\sigma_2}\right)$.

σ_1 is taken as 24 mental months, not far from the standard deviation of a Gaussian 12-year-old age group.



Graph for Table II.

k is $\sqrt{1 - r^2}$ in which r is a reliability coefficient of the form $\frac{\Sigma xy}{n\sigma_x\sigma_y}$.

σ_2 is the standard deviation of any Gaussian group and is here illustrated in the case of $\sigma_2 = 4$, 8, 12, and 16 mental months.

$\frac{x}{\sigma_2}$ is the distance of a line of division from the mean in terms of the σ of the group divided thereby, and in Table II has the value 1.

The formulas permit the computation of values of P_1 and P_2 for any values of σ_1, σ_2, k, and $\frac{x}{\sigma_2}$. They meet two common sense tests:

1. The more heterogeneous the group the smaller the proportion needing remeasurement; and

2. The more reliable the test, the less the need for remeasurement.

Table I is read thus:

If the reliability correlation of a test, *i.e.*, form with form, is .81 as determined in unselected age groups, then

889 per thousand are probably mismeasured by two mental months or more,

779 per thousand by four mental months or more,

204 per thousand by 18 mental months or more, and

1 per thousand by 48 mental months or more.

Table I is pictured as a frequency distribution of errors of estimate of some examination, whose standard error of estimate is, say, six months. The area outside the two ordinates is the number per 1000 whose errors of estimate are greater than three months.

Table II is read thus:

Suppose we give an examination to a school grade having a standard deviation of eight mental months—a somewhat typical situation. Suppose the examination to have a reliability correlation of .96. Suppose the purpose is to divide the group in two at a point one standard deviation below the mean. Then in 94 out of 100 cases measured we are uncertain whether the individual would be on the same side of the line if the test were repeated. If the same group is to be divided in three, at two points each one standard deviation from the mean, by means of the same test, then we are similarly uncertain with regard to all of the individuals.

Table II is pictured by means of a frequency distribution of mental ages, divided at one standard deviation (say eight months), below the mean. The middle of the three ordinates, one of which is so short as to be hardly visible, is the line of division. After giving an examination having a form with form reliability r such that $3\,\sigma k$ in unselected age groups is 10 mental months, we are uncertain, concerning the individuals between the two outer ordinates, whether they are on one or the other side of the line of division. For them remeasurement is accordingly indicated.

Tables I and II are general and apply in any situation in which any examination is used to verify any other examination. Table I reveals the number mismeasured by any examination given. Table II reveals the per cent needing remeasurement when any examination has been given. Two particular cases are these: First, that in which an individual examination, having a reliability correlation of, say, .987, is used for the verification of a group examination having a

reliability correlation of, say, .90; and second, that in which one group examination is used to verify another. Recent progress in the construction of group examinations suggests the possibility of refining these instruments so that their probable errors of estimate shall be as low as those of the best individual tests.

Caution is needed lest we enter Tables I and II with the wrong reliability correlations. It is necessary to obtain the reliability coefficients in each local situation in order that it may be definitely known that the local examiner is obtaining results as precise as those indicated by the coefficients representative of the test when properly used. Error is introduced into routine measurement through the assumption that an examination having a reliability correlation of, say, .987 in an unselected age group when administered by a certain examiner, in a certain place, at a certain time, is yielding measures of equal reliability under other and different circumstances. Classroom teachers who use the results of group and individual examinations may protect their pupils by themselves ascertaining the reliability correlation which is a constant of the local data.

Almost all should be remeasured if the purpose is to divide a group in two at 1σ from the mean, except when the group is extremely heterogeneous and, at the same time, the test is extremely reliable. If either or both of these two conditions fail, then there are occasionally 20 to 30 per cent who need not be measured again. Even then, however, 70 to 80 per cent should be given individual tests in order to be certain that they fall individually within the right group, and if individual measures had been made originally, 100 per cent would then have advantage of closer estimate. If two such lines be drawn by means of group tests, all usually need remeasurement. In school groups two lines have generally to be drawn.

Group tests are of course frequently appropriate instruments. This is true, for example, when the group rather than the individual is the object of study, since measures of central tendency, of dispersion, of correlation, etc., are frequently comparatively reliable, while in the same data, those of individuals are not. It is true again when individuals at one extreme of a very heterogeneous group have to be identified. In such cases, however, it should be definitely determined that individual testing is neither needed nor feasible.

The situations in which it is not proper to give group examinations and then verify doubtful and crucial cases by means of individual testing are, *e.g.*, those in which a school class is to be reclassified,

with demotion, retention, promotion and sectioning, etc., affecting the individuals toward the upper and lower extremes of the group. Such situations are frequent, typical, and of great variety.

Individual Binet testing should, when possible, be an essential and systematic part of a program for public schools. Whenever individual remedy is contemplated, sound policy usually involves the use of such individual tests in the first instance.

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A Teacher's Book on the Problems of Reading

The Materials of Reading, by Willis L. Uhl. New York: Silver, Burdett and Co., 1924. Pp. XIV+386.

Teachers and supervisors in the elementary school have never had an adequate digest and interpretation of the available knowledge concerning reading. Several excellent books have appeared in recent years summarizing the results of investigations of the reading process. In such books eye movement and diagnostic attention has been concentrated on studies and their implications for the teaching of reading. To the present time, therefore, a rapidly growing scientific literature, dealing with the materials of reading instruction, has been lost to the rank and file of teachers.

Professor Uhl's new book *The Materials of Reading* promises to provide the general introduction and interpretation to the entire field of reading which has long been needed. The title of the book is somewhat misleading for not only are the materials of reading discussed but in addition: Children's interests, objects of courses in reading, laboratory investigations of the reading process, classroom teaching and organization of content, diagnostic and remedial work, and measurement of results. The book is, therefore, a systematic treatment of the field of reading instruction.

It is not merely another descriptive textbook in education. The author has taken the time to learn much about his problem and to think through its implications. It is 10 years since Professor Uhl began his technical study of the reading problem. It is refreshing occasionally to encounter educational books that are interpretative and not merely statements of "How to do it." For 15 years, in American education, attention has centered almost entirely on *technique*. Books drop off the press constantly on "How to Measure," "How to Make the Curriculum," "How to Experiment," "How to Study," "How to Teach,"

"How to Learn Easily." We are rapidly becoming an army of skilled technicians—educational trade workers. In the meantime we certainly are unproductive of thoughtful appraisements of our field.

The materials of instruction is both a digest and an appraisal. It assembles in readable form the procedure and results of scores of scientific studies—studies of vocabularies of readers, of the relation between "reading systems" and their content, of the grade-placement of content, of the effect of the physical make up of books, of children's interests, of the social worth of reading, of objectives, of reading courses, of laboratory investigations of the reading process, of diagnostic and remedial work, of measurement of progress, of standards for selecting and organizing reading materials.

The descriptions are representative. The essential features of studies have been culled out and presented clearly. For example no student of the grading of content in reading can afford to neglect Uhl's assembly and handling of the studies in the field. The same is true of other chapters—conspicuously that dealing with children's interests in reading. Some of the topics are chiefly digests of available evidence—Professor Uhl has combed the literature carefully; some are his interpretations of unexplored problems. In these latter the author has not hesitated to venture his own evaluations.

Not the least important aspect of the book is the excellent bibliography. This is a selective guide to the literature of the elementary school reading problem.

I find it very difficult to make adverse criticism of the book. There are few gaps. A typical lack that I feel in it is the omission of other types of laboratory investigations than those of the Chicago School based on eye movements. The correlation technique for studying the reading process, developed especially well by Gages is neglected; likewise the findings concerning the reading process developed by Thorndike in some of his earlier studies. However, these gaps are minor in importance. At most they merely form an interesting example of the influence exerted on us by our colleagues and teachers. And in this respect Professor Uhl is far less guilty than most of our educational writers. He has chosen his examples from a very wide sampling of the literature. Look through any new educational book and note the author's references to the contributions of other workers. Almost invariably the list is dominated by the works of his colleagues and students. Naturally so and for several obvious reasons, the works of his neighbors are best known to him, they are "on tap" and require

little research to locate them, they are on his mind, he feels an institutional interest in them, etc. Whatever the reasons may be the tendency is one that might well be checked in the writing of educational books.

Materials of Reading is to be heartily recommended for teachers and supervisors and for students in our training classes.

HAROLD RUGG.

ON THE TECHNIQUE OF MANUSCRIPT WRITING

Manuscript Writing, by Majorie Wise. New York: Charles Scribner's Sons, 1924. Pp. 54.

One of the most significant characteristics of American education is the dearth of real experimentation. Educational practice becomes crystallized within a given department of knowledge due to the premature adoption of a particular method or of a specific content. We rarely try alternatives. The advocates of experimental method, however, greet eagerly any system of instruction which, adopted in experimental centers, will prove an opportunity of comparison of alternative methods of instruction.

The present reviewer is very much interested, therefore, in the attempt of certain English educators to secure the wide-spread trial of "manuscript writing" in the elementary schools. The movement has spread rapidly in England during the past 25 years. In 1899 Miss M. M. Bridges made the first suggestion for introducing "manuscript writing" into English schools, going back for her copy to the handwriting of the fifteenth century scribes. The Parents National Education Union adopted her book and influenced widely the development of handwriting through home instruction. The movement lay dormant for nearly 15 years. Within the past 10 years, however, a form of script writing was developed resembling closely the Reinhardt lettering used by American engineers.

"Manuscript writing, which has been spreading so rapidly in England during the last few years, is the name given to a simplified form of handwriting which aims at greater legibility, beauty, and speed, by doing away with the unnecessary joinings of the letters, and returning to the plain capitals and miniscules of the Roman alphabet. It is, in effect, a return to the fifteenth century Italian cursive handwriting. It has been found much easier to teach in the early stages, and its help in the teaching of other subjects has not been negligible;

but it has not been taught long enough to know its effect as a more mature handwriting."

The first statement concerning manuscript writing is the recent book by Miss Marjorie Wise. This has been prepared as a result of her experience in several English schools and her experimentation with it in private schools of New York City, especially the Lincoln School and the Horace Mann School of Teachers College. This book gives a brief historical sketch of the movement in England, a statement of the advantages and disadvantages of manuscript writing and provides a systematic set of writing exercises for pupils in the upper grades.

The book has been designed for both teachers and pupils especially for pupils in the upper grades in high school to be used there as a summary or a review for those who have already learned writing, or to be used as a copy book for those who are learning it for the first time. It seems to the present reviewer to provide an admirable opportunity for real experimentation in American schools with a technique which has been widely accepted in England. Rather than accept it uncritically, however, we in America should try it out slowly and methodically in experimental centers, making psychological analyses of the learning processes involved and adequate measurements of results obtained.

HAROLD RUGG.

How Foster Children Turn Out, a study by the New York State Charities Aid Association, made under the direction of Sophie V. S. Theis. New York, 1924. Pp. 239.

In the past 25 years this association has placed in foster homes 910 children who are now 18 years of age or over. This book describes a recent attempt to trace these persons and to determine the degree of success attained by them in adjusting themselves to the conditions of life. It is not a comparative study of adopted children and institutional children, nor of adopted children as compared with children in general. Data for such comparisons were not available.

In addition to discussion and evaluation of the factors of family backgrounds, foster homes, education, health, occupations, and individual case histories, the report presents such general conclusions as the following. Although 80 per cent of the children came originally from homes that would ordinarily be considered a bad background, nevertheless 77 per cent are now capable persons in the sense that they

are able to manage their affairs with average good sense and live in accordance with good standards in their communities. The original homes of only 8 per cent of the children could be judged as good, yet only 12 per cent are now definitely at odds with society or need protection or training of the type given by a state institution or other official body. The age of the child at the time of his placement in a foster home was found to be a significant factor. A larger proportion of the children who were less than five years old when placed in foster homes turned out well than of those who were older. The writers of the report are convinced of the tremendous importance of a favorable environment on the development and direction of the latent powers within an individual. They believe also that the most important condition of successful development is the kind of relationship that grows up between the child and his foster parents. In other words, the human environment matters more than the material surroundings.

Several further studies are suggested by this investigation, which offer unusual opportunities for the scientific consideration of the problem of heredity and environment. The present painstaking and sympathetic study, made as critically as possible under existing conditions is significant not only to social workers and foster parents, or prospective foster parents, but also to all persons interested in the influence of environment upon children's development.

J. H.

Mental and Educational Hygiene

The Normal Mind, by William H. Burnham. New York: D. Appleton and Co., 1924. Pp. XVIII+702.

Seven hundred pages on normalcy are not a very allurin prospect for a reviewer but a few of the 21 chapter headings looked sufficiently promising to warrant piecemeal attack. The introductory chapter must, of course, be read. Most readers of this periodical will be able to take the next six chapters for granted but they are essential as an approach for those who are not already familiar with the fundamental factors of modern psychology. There remain about 400 pages in which mental hygiene is discussed positively and clearly, from a prophylactic point of view, and two brief lucid chapters on the problems of seriously maladjusted individuals.

The book is surprisingly easy to read and will no doubt be widely used because of its sane constructive treatment of problems of person-

ality in which such professional workers as educational psychologists, teachers, doctors, nurses and social workers are not more interested than laymen who respect the social responsibilities of parenthood. Frequent reference to scientific studies throughout the text must gratify those who are of a critical turn of mind; the bibliographies, problems, questions and chapter summaries will appeal to those who are in search of a textbook for college courses or study groups.

The development and maintenance of integrated personality is the major problem. The author maintains that the essential characteristic of the normal mind is integration, and that the most essential aim of education may best be achieved by provisions for coordinated activity, physical and mental, in the doing of significant tasks. He illustrates and expands this principle throughout the book. The following quotations are particularly significant because of their educational implications:

"Progress requires the ability to break down old habits and systems of thought. Just as soon as a man loses the ability to do this, arrest of development begins. As soon as one gets a closed system, in philosophy, or in education, or what not, further development ceases. The system may be an admirable one and an economic device that will enable the individual to do most efficient work, but further development ceases here. . . . Fortunately, conditions in this world do change, and this makes readjustment, reorganization, adaptation necessary. . . . From this point of view the function of education is the mediation between old and new habits, usually between habits of a lower order and habits of a higher order." P. 187.

"Very likely there are two distinct types (of individual learning): On the one hand, those who, for the most part, acquire habits only by the slow process of repetition; on the other hand, those who acquire many habits by shock, as we have called it, or a single vigorous initial reaction." P. 195.

The important effects of attitudes are enumerated and their bearing on physical and mental health is demonstrated. Causes of school difficulty are enumerated. Among them is over-didactic instruction with the emphasis on "teaching" rather than "learning."

The author states his principles concisely in the chapter preceding the last in the book, after their concrete application has been vigorously illustrated, and then puts them in tabloid form as "Practical Rules for Mental Health."

This adaptation to the vagaries of human nature and the frailty of intellectual endeavor is entirely praiseworthy, combined as it is with due respect for scientific attitudes and tempered with a proper respect for the limitations of data. The combination is rare and satisfying.

LAURA ZIRBES.

EXPERIMENTAL DETERMINATION OF THE EFFECT OF TOBACCO

The Influence of Tobacco Smoking on Mental and Motor Efficiency, by Clark L. Hull. Psychological Review Co., Princeton, New Jersey, 1924. Pp. 161.

This monograph reports in a clear and attractive manner the procedure and results of a very carefully planned and executed scientific experiment. The purpose of the experiment was to determine quantitatively the effect of smoking upon certain mental and neuro-muscular functions. Nineteen young men, including smokers and non-smokers were used as subjects. The unique feature of this experiment was the use on alternate days of an ingeniously devised control dose in place of the regular pipe of tobacco. The subjects were, however, entirely unaware of the fact that they were not smoking as usual every day.

The results of the experiment show that smoking a pipe-full of tobacco causes a marked and uniform stimulation of the heart rate, which persists for at least one and one-half hours after the smoking. A large increase in the tremor of the hand is shown, but this effect largely disappears in 80 minutes. The most marked effect upon psychological functions was found to be a considerable gain in the rate of complex mental addition. Other results are important but less marked.

This monograph will prove valuable not only to those who are interested in the effects of drugs upon human reactions but also to all who are interested in the technique of psychological experimentation. A summary of previous investigations of tobacco effects is given.

J. H.

WHAT ENGLISH PSYCHOLOGISTS THINK ABOUT TESTS

Psychological Tests of Educable Capacity, Report of Consultative Committee of the Board of Education. H. M. Stationery Office, Adastral House, Kingsway, London, W. C. 2, England. 1924. Pp. XII+248. Price 2 Shillings net.

This report impresses me as being the best interpretive analysis that has yet been made of psychological and educational tests. It aims to answer the question: "What use can be made in the public system of education of psychological tests of educable capacity?" In order that American students will not misinterpret the scope covered by these terms it should be noted at once that "psychological" tests includes tests for "intelligence;" tests for attainment in scholastic subjects; vocational tests adapted for use in schools; tests of mental activities of a specialized kind, *e.g.* tests of memory, perception, attention, imagery and association; selected physical tests bearing on educable capacity; and tests of certain aspects of temperament and character. In other words, we have in this book a review and a critique of the whole field of testing to public education.

The method followed is interesting and highly suggestive—the method of oral and written symposium. The lay "committee," financed to the extent of some $5000, sat on 41 separate days and interviewed 37 specialists including the most conspicuous workers in the field in England; *e.g.* Cyril Burt, Charles S. Myers; C. E. Spearman, and P. B. Ballard. A stenographic record supplied a vast wealth of material from which a final critique of the entire problem was written. This was supplemented by several documents written by leading specialists in the field. For example, Dr. Burt wrote an admirable historical review of the development of psychological tests. In that he illustrated and evaluated critically the stages of progress from the early use of simple sensory and motor tests, to the latest crude attempts to measure character. In this historical statement is included also the use of correlational methods, the Binet-Simon Scale and its modifications, the development of group tests and performance tests since 1917, the recent movement for the construction of educational tests of attainment, tests for vocational aptitude and tests of temperament and character. Dr. Burt's review is the most scholarly and balanced statement of the growth of the movement in various countries that I have encountered. It should form a part of the required reading of students of psychological and educational measurement in American institutions.

Such students and their teachers will be immensely interested in the main body of the report which follows the historical chapter. Two problems are treated: one—the problems of interpreting the available evidence concerning psychological tests; two—the possible uses of tests in schools.

In these sections of the report we have a very critical and constructive evaluation of the problem of measuring intelligence, educational attainment and character qualities. The various hypotheses concerning the nature of intelligence are considered. The Thorndike-Spearman controversy is reviewed. The extent to which "intelligence" tests measure "constant" capacities is taken up. The merits and disadvantages of the Binet-Simon Tests, with the various modifications, American, Italian, and English are carefully analyzed. The relative merits and disadvantages of group and individual tests appear.

Throughout the report the statements embody careful evaluation and temperate conclusions based on the judgments of experienced workers in the testing field. As an evaluation in a field of controversial discussion it has the merit of being the product of the cooperative effort of the best minds in English educational psychology.

HAROLD RUGG.

THE INTELLIGENCE OF IMMIGRANTS' CHILDREN

A Comparative Study of the Mental Capacity of Children of Foreign Parentage, by May Bere. New York: Teachers College Contributions to Education, No. 154, Teachers College, 1924. Pp. 105.

This book reports an investigation of the abilities of children of three immigrant groups in New York, City namely, Italians, East European Hebrews, and Bohemians. A sampling of 10-year-old boys of each group was so made that it included representatives from the various colonies in the city and from different social and occupational levels. These groups were tested with the Stanford-Binet, National Intelligence and Pinter-Patterson Performance Tests.

On the Stanford-Binet, the groups were found to rank as follows: Hebrew, Bohemian, and Italian. The median intelligence quotient of each group was less than 100. Measured by performance tests the differences of the groups were less and the rank order was Bohemian, Italian, and Hebrew. These results indicate a difference in the nature of the abilities of the groups. The author states that correlations between the test results and length of residence in America of parents and use of English in the home do not support the argument that a language handicap is responsible for low intelligence quotients. The relation between test scores and occupational status of parents is reported as similar to that of children of native parentage. The implications of the findings for immigration are summarized.

The results of this study are in general agreement with others that have attacked the problem of the mental capacity of the different racial groups. It is to be hoped that the accumulation of evidence upon this subject will result in a rational and equitable treatment of the immigrant and of the immigration problem.

J. H.

Prediction of Success in Latin

Detailed Factors in Latin Prognosis, by Orlie M. Clem. New York: Teachers College Contributions to Education, No. 144, Teachers College, 1924. Pp. 52.

The study described in this monograph supplements a previous investigation made by Dr. Wm. S. Allen in the Boy's High School, Brooklyn, entitled: *A Study in Latin Prognosis.* Dr. Clem's purpose was to find the effect of certain detailed factors upon a pupil's success in first year Latin, to select the most effective factors and to obtain their combined prognostic value. The subjects of the study were some 400 pupils of three high schools of New York and Brooklyn. The value in prognosis of 60 separate items is measured by a battery of 11 Latin Criterion Tests, through the use of multiple correlation.

The results show the best single objective measure for predicting success in first year Latin to be the Briggs Analogies Test, which show a consistent correlation of .50 with the criterion. A correlation of .80 or above is obtained by the combined use of the Briggs Test Beta, Age, Thorndike Test of Word Knowledge B, average of all marks for the last year of elementary school, and the Latin teachers' judgment of the pupils on 11 character and industry traits.

Such results indicate the possibility of substantial reduction in the amount of misdirected educational effort that now exists in the work of high school freshmen.

J. H.

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